BRITISH VOLUME
Vol. 36-B, No. 4

NOVEMBER 1954

The Journal of Bone and Joint Surgery

IN HONOUR OF
GEORGE PERKINS

THE JOURNAL OF THE ENGLISH-SPEAKING WORLD

PUBLISHED JOINTLY IN LONDON, ENGLAND
AND BOSTON, UNITED STATES OF AMERICA

The Journal of Bone and Joint Surgery

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The Journal is published in ten annual numbers. The six American numbers are issued on **January 1**, April 1, June 1, July 1, October 1, and December 1; and the four British numbers are issued on **February 16**, May 16, August 16, and November 16. **The subscription price,** payable in advance, for the four British numbers alone, is £3 (10 dollars), or for the six American numbers alone, £4 (13 dollars). The combined subscription price for both British and American volumes is £6 (20 dollars).

The Journal is published in the United Kingdom for The British Editorial Society of Bone and Joint Surgery Limited by Messrs E. & S. Livingstone Ltd., 16–17 Teviot Place, Edinburgh; and 48 Bloomsbury Street, London, W.C. 1. British Editorial Offices: 82 Portland Place, London (Tel. Langham 1378). Editorial Secretary to the British Board: Miss Jean Barnes.

The Journal is published in the United States of America by The Journal of Bone and Joint Surgery, Incorporated. American Editorial Offices: 8 The Fenway, Boston, Massachusetts, U.S.A. Assistant Editor to the American Board: Miss Florence L. Daland.

THE JOURNAL

OF

BONE AND JOINT SURGERY

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PUBLISHED IN LONDON BY MESSRS E. & S. LIVINGSTONE LTD.

AMERICAN VOLUME PUBLISHED AT 8 THE FENWAY, BOSTON, MASS.

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THE JOURNAL
OF
BONE AND JOINT SURGERY

OFFICIAL PUBLICATION OF THE

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The Journal of
Bone and Joint Surgery

EDITORIALS AND ANNOTATIONS

EXPERIMENTAL SURGERY

In June of this year, nineteen hundred and fifty-four, Alfred Rives Shands,* Jun., M.D., gave his presidential address to the annual meeting of the American Orthopaedic Association. His opening sentence stressed the need in our speciality for "a sense of responsibility, vision and research." His subsequent statements suggest that he placed these qualities in that order deliberately. Speaking of operative procedures which have resulted from the development of new materials, he said, " In recent years many new operations, particularly those associated with the use of metals and plastics, have not had ' the test of time.' It is as much our responsibility to protect the public from operations of unproved value, as it is to protect it from the use of inferior materials." He quotes Gallie who said, " . . . we are dealing with human lives. How much more important, therefore, that we should test our ideas thoroughly before trying them on our patients or committing them to print." And Shands goes on to comment that every new operation, orthopaedic or otherwise, " has left a wake bestrewn with poor results and even surgical tragedies."

These are strong words, and it might be argued that if taken too much to heart, they would preclude or postpone indefinitely any advances in operative surgery. It might be said that in the past great surgeons boldly disregarded the qualms of their more timid fellows, and embarked fearlessly on completely new operative ventures, which subsequently came to be universally acclaimed and adopted with untold benefit to successive generations of patients. An examination of the facts of surgical history does not justify such a statement. Anyone interested to search, will find that the innovations were modifications of established, well tried and reasonably successful procedures, and that the innovators were surgeons of great experience and judgment. The " new models " were built on solid foundations by men whose training and previous practice rendered them well able to calculate, with reasonable reliability, the probable result of the additions or alterations to the main structure. Most operative patterns changed only gradually, as if by " creeping substitution," and when indeed a totally different or novel operation was launched, it had usually been tested by animal experiments. To-day, on the other hand, many operations bear no relation to their predecessors, and are founded neither on experiment nor on experience: neither the principles underlying them, nor the materials involved, have been reliably tested in the role they have to play. If, when they have failed to come up to expectations, the patient is not worse off than he would have been if left alone, then no great harm is done. But if, as so often happens, the patient passes through a miserable period, at the end of which he is materially more disabled than if he had never undergone the operation, then indeed is he in the " wake bestrewn with poor results and even surgical tragedies."

It is self-evident that to publish accounts of operative treatment, founded on inadequate knowledge and dependent on uncertain factors, of procedures lacking scientific justification or empirical proof, can materially increase the risk referred to by Dr Shands. In a Journal such as this, publication may be even more harmful, for it is associated, inevitably, with some degree of approval and recommendation. On the other hand, it may be said that a

* SHANDS, A. R. (1954): Responsibility and Research in Orthopaedic Surgery. Journal of Bone and Joint Surgery, **36-A**, 695.

declaration that such and such an operation is being tried out with the patient's acquiescence in the full knowledge that it is an experiment, may induce many surgeons with similar ideas to await the outcome. It may further be said that the duty to exercise vision, and to encourage research, must be borne clearly in mind, and that we should be failing in both respects if new ideas and fresh ventures were not speedily proclaimed. It would be very nice to believe these statements, but in the meantime it is necessary for Editorial Boards, and those to whom they are responsible, to decide where their duty lies.

The Victoria Building of Liverpool University bears a tablet recording that it was erected " for advancement of learning and ennoblement of life." This could well serve as an indication of the *raison d'etre* of this Journal. It might not be unreasonable to contract the scope a little and say that the Journal was created " to disseminate knowledge and benefit mankind."

In the question which now arises, it appears difficult to reconcile these two purposes, and it seems to me that the only solution lies in compromise. Let the Journal publish an account of operations and procedures on trial, briefly, and with a clear indication that they are experimental and therefore *sub judice*. In that it is reminiscent of the attention drawn to poisons and overdrafts, the heading of the section could appropriately be printed in red.

For example, the contribution in this issue of the Journal by Mr Shiers who has tried to perform an arthroplasty of the knee by means of a metal device with a hinge secured to the femur above, and the tibia below, would most certainly be headed Experimental Surgery—and for some of us the more red the heading the better it would be.

BRYAN MCFARLAND.

BIOPHYSICS AND BONE STRUCTURE

Our knowledge of the finer structure of animal tissues is obtained by means of some physical method of examination. The method of conventional histology—that is, the microscopic examination of fixed and sectional material—immediately comes to mind. It should be remembered, however, that this is only one of a considerable number of techniques—including microscopy with ultra-violet light, phase contrast microscopy, interference microscopy, electron microscopy, x-ray microscopy (microradiography) and x-ray diffraction—that may be used to obtain structural information about biological material.

In a number of different countries special groups of research workers have come to devote themselves to the specific physical and biophysical problems concerned in this type of investigation. A notable research group of this kind is the Department of Physical Cell Research of the Karolinska Institute in Stockholm. It was from there that Professor Caspersson's outstanding studies* on the microscopic distribution of nucleic acid within the cell, as shown by the absorption of ultra-violet light, were carried out. More recently, great impetus to structural studies of bone tissue has been provided by the work of Professor Engström and his associates on the application of biophysical methods to bone. In particular, the technique of microradiographic examination has been found a very profitable one. In 1950 Engström and Amprino† showed that the distribution of the mineral material of bone could be investigated on the microscopic scale by preparing radiographs of thin sections of bone and subjecting the radiographs to high optical magnification. The same authors published further work on this subject in 1952‡, when they described in some detail hitherto unsuspected differences in the degree of mineralisation of different areas of normal bone tissue with

* CASPERSSON, T. O. (1950): Cell Growth and Cell Function: a Cytochemical Study. New York: W. W. Norton & Company.
† ENGSTRÖM, A., and AMPRINO, R. (1950): X-ray Diffraction and X-ray Absorption Studies of Immobilised Bones. Experientia, **6**, 267.
‡ AMPRINO, R., and ENGSTRÖM, A. (1952): Studies on X-ray Absorption and Diffraction of Bone Tissue. Acta Anatomica, **15**, 1.

identical histological appearances. The concept of osteoid tissue—that is, bone matrix devoid of its mineral constituents—is an old one, but these studies have extended our ideas of bone mineralisation and have shown that bone tissue may present all intermediate degrees of mineralisation ranging from osteoid tissue to fully calcified bone. Even under normal conditions, when uncalcified osteoid tissue itself does not occur, considerable local variation in the degree of mineralisation of bone is found.

In addition to this interesting work on normal bone structure, Engström and his associates have published a series of papers dealing with the application of biophysical techniques—and microradiography in particular—to specific bone diseases, including Paget's disease and osteopetrosis. One paper of this series, by Engfeldt, Engström and Zetterström, dealing with bone changes in osteogenesis imperfecta, appears in this issue of the Journal. The techniques used by these investigators confirm what we already know from conventional microscopic studies regarding the structural irregularity of bone in osteogenesis imperfecta, and add new information regarding the distribution of mineral material in the bone, their results suggesting that, on the microscopic scale, this is more uniform than is found in normal bone.

One can be quite sure that more papers will be added to this series on biophysical studies of bone tissue, and that further interesting and important information on the mineralisation of both normal and pathological bone will result from the continued application of the methods outlined by Engström and his colleagues. H. A. Sissons.

REPORT OF THE BRITISH ORTHOPAEDIC ASSOCIATION ON POLIOMYELITIS

The problems of poliomyelitis relate first to the saving of lives and then to the saving of limbs. This disease does not often kill but it nearly always cripples. There must surely be a balance of thought and action between the physicians who are concerned with bulbar paralysis and the saving of life, and the surgeons who for many years thereafter will treat residual paralysis and contracture. They can both work together; of course they can—and of course they should. If this is so, why is it not so from the beginning? This issue of the Journal includes the report of the British Orthopaedic Association on the problems of poliomyelitis which is short and brief. The shorter it is, the more important it is—which is often so. The observations apply not just to Great Britain but also to the United States and indeed to every other country. Editor.

THE BRITISH EDITORIAL BOARD

It is with dismay in the loss we are sustaining, but with pride in the achievements that have been made, that we have had to accept the resignation of George Perkins as chairman of the British Editorial Board. He inspired the British Volume of the Journal of Bone and Joint Surgery. Without him there would probably never have been a British Volume of this Journal. He thought of it long before it started. In pursuing his thought he overcame every obstacle. This number is dedicated to George Perkins, inspirer of the British Volume of the Journal of Bone and Joint Surgery and chairman of its Board almost from the beginning until now. Editor.

BONE ANOMALIES OF THE TARSUS IN RELATION TO "PERONEAL SPASTIC FLAT FOOT"

E. A. Jack

Harris and Beath (1947) made a valuable contribution to surgery when they described for the first time the developmental anomaly at the sustentaculum tali—the talo-calcanean bridge—as an important and frequent element in the production of rigid flat foot. They also performed a further service by drawing attention to the hitherto rather neglected papers of Slomann (1921) and Badgley (1927). Both these authors described another congenital anomaly —the calcaneo-navicular bar—in association with so-called spastic flat foot, but their work went practically unheeded by their surgical colleagues. Seven years ago the etiology of peroneal spasm and rigid flat foot was still something of a mystery. Treatment was mainly empirical and usually unsuccessful. The fact that special radiological projections are required in order to reveal the anomalies is probably the reason for their prolonged obscurity.

In consequence of the stimulation of Harris and Beath's contribution, all patients with peroneal spasm or rigid flat foot, excluding those with rheumatoid arthritis, seen since 1949 have been made the subject of special study. This paper presents an analysis and discussion of the main features in thirty patients, twenty-seven of whom reported with the usual symptoms and signs. Three others reported for other reasons and, in the course of routine examination, were found to possess one or other of the bone anomalies. They have been included in order to further knowledge of the behaviour of these anomalies. For the sake of convenience the short descriptive terms suggested for these anomalies by Harris and Beath —the talo-calcanean bridge and the calcaneo-navicular bar—will be used throughout.

Since Harris and Beath's paper, a report has been published by Webster and Roberts (1951) on twenty-one patients with peroneal spasm or rigid flat feet, of whom tarsal anomalies were found in fourteen.

TABLE I

Incidence of Talo-Calcaneal Bridge and Calcaneo-Navicular Bar in Sixty-eight Cases of Rigid Flat Foot

Author	Number of cases	Talo-calcanean bridge	Calcaneo-navicular bar	Both	No bone abnormality
Harris and Beath	17	12	3	0	2
Webster and Roberts	21	4	8	2	7
Jack	30	11	12	0	7
Totals	68	27	23	2	16

This series of thirty patients includes twenty-three who had one or other of the anomalies. Twelve patients had calcaneo-navicular bars (nine bilateral and three unilateral) and eleven had talo-calcanean bridges (three bilateral and eight unilateral). Only seven of the thirty presented no evidence of one or other anomaly. The cases are summarised in Table I, which shows that in the aggregate of the three series mentioned a bony anomaly was present in over three-quarters of the cases.

[When Mr Jack died some months ago he left a lot of manuscript material about congenital anomalies of the foot which he had clearly intended to submit for publication. We are most grateful to Professor Walter Mercer and Mr James Scott for their endeavour in completing the contribution as Jack would have wished—and thus making so important a posthumous recognition.—Editor.]

THE NATURE OF THE BONY ANOMALIES

The calcaneo-navicular bar and the talo-calcanean bridge are similar anatomical defects with similar developmental cause, so they may conveniently be considered together. Previous authors have fully described the physical appearance of these anomalies. In each case the tissue uniting the two main bones may be completely osseous (synostosis), or the bone may be

FIG. 1
Os calcaneum secondarium.

FIG. 2
Calcaneo-navicular bar of medium breadth with a wide fissure.

divided by a fissure of varying depth which may consist of cartilage (synchondrosis) or fibrous tissue (syndesmosis) (Figs. 1 to 9). The authors of most earlier papers quoted from the work of anatomists of fifty years or more ago, particularly that of Pfitzner, who described two small accessory bones occasionally found in each situation—the os sustentaculi and the calcaneum secundarium (Fig. 1). The tendency has been to consider that the accessory bone

lies at the root of the trouble and that its fusion to one or other, or to both, of the main bones is the cause of the syndesmosis, synchondrosis or synostosis. This view is not entirely acceptable and, although the argument is purely academic, comment is justified.

From the examples illustrated it is obvious that the bony processes vary considerably in their nature and dimensions. A calcaneo-navicular bar may be a massive structure, well over an inch in width, and it may extend across to the medial side of the navicular bone. A talo-calcaneum bridge may also be wide, and it may involve the whole of the sustentaculum facet as well as the area behind it. Fissures may be oblique or central and they are not necessarily confined to one or other extremity of the bony bar. Radiographically, only a small proportion of the anomalies present anything to suggest that they are derived from an accessory bone that has fused on one side or the other.

FIG. 3

FIG. 4

Figure 3—Broad calcaneo-navicular bar seen in oblique view. Figure 4—Broad calcaneo-navicular bar seen in antero-posterior view demonstrating its width.

The origin of the abnormality goes back to the early differentiation of mesenchyme which is destined to form the tarsal region, to the laying down of pre-ligament and pre-cartilage tissue, and to primitive joint formation as a whole. An error in this differentiation (possibly hereditary) may lead to a large complete bony fusion at one extreme, or to a small accessory bone at the other extreme. Both are variations in degree of the same anomaly.

Radiographic diagnosis—It is well known that the bony anomalies are difficult to detect in the routine antero-posterior and lateral projections of the foot, and that special oblique views of the foot and axial views of the heel are essential for diagnosis. The technique of these projections has been fully described elsewhere. One of the radiographic features which Harris and Beath emphasised particularly is the bone spur which forms on the dorsal and lateral side of the head of the talus. This spur formation is by no means diagnostic of a tarsal anomaly. It occurs in other conditions in which there has been long-standing valgus deformity

at the midtarsal joint. In the present series of cases spurs were seldom found in the young patients, but became more constant after the age of sixteen. They tend to develop during adolescence in cases with severe persistent symptoms (Fig. 10), and in older patients with rigid eversion of the foot. They may become large, and, in fact, the whole navicular may become enlarged so that the naviculo-cuneiform joints are also spurred. In patients with

FIG. 5

FIG. 6

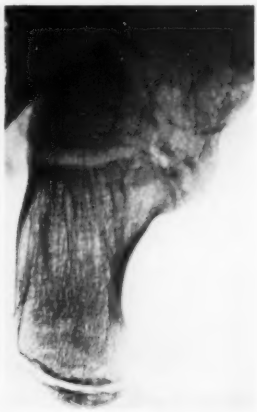

FIG. 7

Figure 5—Axial view of normal subtalar joint. Figure 6—Similar view of same patient's other foot with complete talo-calcanean bridge. Figure 7—Axial view of massive talo-calcanean bridge with an oblique fissure.

FIG. 8

FIG. 9

Figure 8—Axial view of massive talo-calcanean bridge with horizontal fissure. Figure 9—Oblique view of the same structure to show its width.

severe persistent spasm spurs may form not only on the supero-lateral aspect of the talus, but also on the supero-lateral aspect of the cuboid and calcaneum (Fig. 11).

CLINICAL FEATURES

Both anomalies produce rather similar symptoms and deformity although there are distinct variations in the severity and degree. A comparative analysis of the clinical features found in twenty-three cases is therefore instructive. For ease of reference, the leading features are summarised in Tables II and III.

TABLE II

AGE AT ONSET AND PERIOD OF OBSERVATION

Calcaneo-navicular bar (12 patients: 9 bilateral, 3 unilateral—21 feet)	
Age when first seen	9, 10, 10, 11, 12, 12, 14, 15, 15, 23, 28, 32
Age at first symptoms	9, 11, 8, 11, "childhood," no symptoms, 14, 14, 15, 13, 28, 14
Age at last review	10, 13, 11, 13, 18, 14, 17, 15, 19, 24, 28, 32
Talo-calcaneal bridge (11 patients: 3 bilateral, 8 unilateral—14 feet)	
Age when first seen	13, 13, 13, 13, 13, 13, 15, 15, 15, 16, 38
Age at first symptoms	13, 13, 12, 12, 8, 13, 13, none, 15, 16, 15
Age at last review	18, 16, 18, 20, 16, 14, 19, 16, 15, 18, 38

TABLE III

ANALYSIS OF MAIN SYMPTOMS AND SIGNS

(*Numbers refer to feet*)

	21 feet with calcaneo-navicular bar	14 feet with talo-calcanean bridge
Transient pain and spasm subsiding with treatment	8	2
Persistent symptoms or relapse after initial transient spasm	5	11
No symptoms	8	1
Bilateral anomaly with unilateral symptoms	4	0
No typical symptoms—defect found on routine examination	4	1
Spasm noted at some stage	11	10
Eversion	19	13
No eversion	2	1
Subtalar mobility		
Nil	7	12
Under 50 per cent	5	2
50 per cent and over	6	0
Normal	3	0
Complete bony bars		
Mobility nil	4	9
Narrow fissure		
Mobility nil to 50 per cent	7	0
Mobility nil to 25 per cent	0	5
Narrow bar with wide fissure		
Mobility 25 per cent to 100 per cent	10	0
Subjected to operation	4	5

(Several patients still too young for this assessment)

Age incidence—Although there is the odd patient in each group in whom symptoms started during early childhood, by far the commonest age at which children began to complain was between the ages of twelve and fifteen years—that is, during the age of rapid ossification and bone growth. The calcaneo-navicular bar seems likely to produce symptoms at a slightly earlier age than the talo-calcanean bridge. This may well be because the first anomaly involves the midtarsal joint, which is more liable to strain or trauma than the subtalar joint during normal childhood activities. The anomaly, too, is a much longer structure and therefore subject to much greater leverage.

Symptoms and signs—From the symptomatic viewpoint the patients in this series fall conveniently into three categories.

In the first category are those who complained originally of an acute incident of pain and peroneal spasm which settled permanently after treatment. In a high proportion of these patients there was a history of some minor injury—a twist or a kick on the foot—shortly before the onset, though this was not a constant factor. Severe injury, sufficient to cause a

FIG. 10

FIG. 11

Figure 10—Spur on dorso-lateral aspect of the head of the talus associated with a talo-calcanean bridge. Radiographs taken four years previously showed no such abnormality. Figure 11—Spurs on supero-lateral aspect of calcaneum and cuboid associated with a talo-calcanean bridge.

fracture of a calcaneo-navicular bar or disruption of a fibrous fissure (Harris and Beath) has never been encountered. Treated by relief from weight bearing either in bed or in a plaster for four to six weeks and thereafter by a course of physiotherapy, many of these patients lost their spasm and pain and were able to carry on without real disability despite some restriction of subtalar mobility and some eversion of the heel. This transient incident of spasm subsiding with treatment was commoner in patients with a calcaneo-navicular bar and was unusual in those with a talo-calcanean bridge.

In the second category were those who complained of chronic persistent pain and stiffness or who relapsed after an acute incident of spasm. These symptoms were much commoner in patients with a talo-calcanean bridge; eleven of the fourteen feet fell into this category. Only five patients with calcaneo-navicular bars were in this category but the figure is probably misleading because four of these patients had barely entered puberty and were too young for assessment. They may very well develop symptoms and disability later.

The third category comprises patients who have anomalies without symptoms. Only one patient with a talo-calcanean bridge came into this grading—a boy of fifteen with bowed

tibiae and compensatory valgus of both feet. The right heel was mobile, the left fixed by a typical bridge with a fissure. He plays all games and has never suffered pain or disability.

Eight feet with calcaneo-navicular bars were symptomless. Four of these were in bilateral cases in which only one foot was troublesome. The bar in the asymptomatic foot was of the narrow, poorly developed type with a wide fissure or possibly a joint across it. Slomann (1921) reported two such cases in his series of five. As is shown later, there is a distinct association between the size of the bar and the severity of the deformity and symptoms. In the remaining four feet (two patients) the bony anomaly was discovered on routine examination. One patient admitted to some trouble with the feet when he was fifteen. Thereafter he had served in the Army, doing normal marches and playing games without complaint. At thirty-two he served in a shop, standing all day. He reported complaining of a disorder of the knee and was discovered to have rigid eversion of both heels, with well developed calcaneo-navicular bars. The second patient reported at the age of twelve with mild hallux rigidus. There was some limitation of subtalar movement, and bilateral calcaneo-navicular bars with fissures were demonstrated. Three years later he was free from symptoms; he played tennis and other games and planned to join the Royal Air Force. The left subtalar joint had a quarter of the normal range and the right half. On the left side spurs were beginning to develop on both talus and cuboid. He may yet develop disability.

Spasm—True peroneal spasm, often also involving the extensor digitorum longus, was noted frequently at some stage during the course of observation, usually in the younger patients. The spasm could be relaxed by anaesthesia, or by a period of rest from weight bearing. In this series it occurred rather more commonly in the feet with talo-calcanean bridges—ten out of the fourteen feet, against eleven out of the twenty-one feet with calcaneo-navicular bars. Webster and Roberts (1951) noted it more often in the latter group and there is probably little difference between the two groups in a large series.

Eversion—Eversion of the heel, varying from a minor to a gross degree, was almost the rule, but with each anomaly there was that exception which makes the rule invalid. Slomann (1921) was mystified by one of his cases, that of a girl of ten years, who complained of acute pain in the foot after a minor injury. He found a complete calcaneo-navicular bar in a normally arched, well balanced foot, and was at a loss to explain the absence of deformity. The answer probably lay in the age of his patient.

In this series one patient with a complete talo-calcanean bridge reported at the age of fifteen with a minor attack of spasm and pain which yielded successfully to rest and physiotherapy. At the age of seventeen she undertook all normal activities and wore a high-heeled shoe most elegantly. She had no complaint except an occasional tendency to sprain her ankle on rough ground. The hind-foot was rigid but plantigrade.

Two feet with calcaneo-navicular bars presented no eversion at the heel. One belonged to a patient who had no symptoms at all until a mild sprain at the age of twenty-eight revealed the anomaly. The second was in a case that demonstrates well how careful observation over the whole period of childhood and adolescence is necessary before the true behaviour of these anomalies can be known. A young girl of ten came complaining of tiredness in both feet. Both feet were highly arched: the right heel was inverted and the left heel plantigrade. Subtalar movement was restricted on both sides. Radiographs showed bilateral calcaneo-navicular bars, the right a slender one with a wide fissure, the left a rather broad bar with a narrow but well defined fissure (Figs. 12 and 13). At age eleven she had a transient attack of pain and spasm in the left foot which settled with treatment. Now, at age thirteen, the left foot is no longer cavus and the heel is everted. Radiographs show a broad bar on the left side with a fissure just visible. Spurring of the talar head has started. The right foot remains cavus and the heel remains inverted. There is still a wide central fissure across the bar on the right side. On both sides there has been considerable increase in the ossification of the bar and in its relative bulk.

Subtalar mobility—As is to be expected, movement at the subtalar joint is nearly always abolished by a talo-calcanean bridge. Only two feet in this group had a trace of movement and in both instances there was a well defined fissure across the bony bridge. There may, however, be quite a good range of movement in the presence of a calcaneo-navicular bar if the bar is poorly developed.

FIG. 12
Slender calcaneo-navicular bar with wide fissure in the right foot.

FIG. 13
Medium-broad calcaneo-navicular bar with a narrow, well defined fissure in the left foot of the same patient.

PERONEAL SPASM WITHOUT BONE ANOMALY

There remain to be described the seven patients who reported with undoubted peroneal spasm but in whom neither of the two bony anomalies was found. Harris and Beath included only two such cases in their series, both due to rheumatoid arthritis. Webster and Roberts did not discuss this group at all. Patients with rheumatoid arthritis have been excluded

from this series because it is felt that the condition in that disease is well known and the supply of cases almost unlimited.

One young boy of ten was observed for two years with recurrent peroneal spasm and pain; eventually it became clear that he had a tuberculous infection of the talus. Two others presented rigid everted feet some years after an atrophic arthritis of the tarsal joints. Secondary osteoarthritis of the tarsus was the cause of the rigidity.

The remaining four patients were the most interesting. They reported between the ages of nine and fifteen with true peroneal and extensor spasm, and pain affecting one foot. In two there was a clear history of injury to the foot a short time before the onset of symptoms, and in two a reasonably definite story of occupational strain. In all four patients the spasm and pain subsided completely with rest from weight bearing followed by physiotherapy. Seen two years later, all had normal mobile painless feet and had made a complete recovery. As an example, a boy of fifteen left school and started in a tailor's shop where he worked a heavy treadle machine with his left foot all day long. In three months he developed severe peroneal and extensor spasm. Radiographs of the foot showed a moderate flat-foot deformity

FIG. 14
Post-traumatic spur on dorsum of head of talus.

without sign of bony anomaly. After six weeks' treatment his pain and spasm cleared, leaving some stiffness in the peritalar joint. He was kept on foot exercises for two months. Seen two and a half years later he was working as a miner on rough ground without any symptoms from the foot, which was fully mobile. Radiographs showed a spur on the dorsum of the talus unlike that developing with the bony anomalies, but much more like the spurs that form after tear of the capsular ligament (Fig. 14).

In these four cases the spasm was related to trauma or chronic strain of the ligaments controlling the midtarsal and subtalar joints. The mechanism of production is probably that described by Lapidus (1932, 1946). Spasm may also occur as the result of an infective lesion of the joints. Rigid flat foot may develop at a later stage from chronic irritation or degeneration in the joints.

DISCUSSION

It is appropriate at this stage to discuss some of the main clinical findings in the present series in the light of the conclusions arrived at by other authors, expecially those of Harris and Beath (1947). While there is no wish to minimise the importance of their valuable contribution—description of the talo-calcanean bridge—several of the assertions they made

are difficult to reconcile with the facts that present themselves on clinical observation. It is easy, when one has made an original and important new discovery, to be led away by enthusiasm into inaccurate conclusions. Possibly the patients on whom they based their assertions were older than those of the present series and the series reported by Webster and Roberts (1951).

Age incidence—The first point for argument concerns the age at onset of symptoms and disability. Slomann (1921) reported one case of calcaneo-navicular bar with trouble at four years, and four cases with symptoms beginning at ten years or over. Badgley (1927) stated that symptoms in calcaneo-navicular bar start uniformly at puberty. Webster and Roberts agreed with this view in both types of anomaly, with the reservation that some rigidity of the heel is probably present, but unnoticed, during childhood.

Harris and Beath stated that these anomalies frequently cause trouble in early childhood. They argued that because the deformity is a congenital one it must cause abnormality. They even went so far as to suggest that the anomaly is, rarely, detected before the child begins to walk, when a diagnosis of calcaneo-valgus is made, and the true lesion can be visualised by special projection. This seems a little optimistic and probably purely conjecture. No evidence is offered to support the suggestion. They also suggested that calcaneo-navicular bars might produce symptoms in early childhood.

The patients in the series reported here came from an area which is well covered by school orthopaedic services. All school children have their feet examined carefully on admission to school at the age of five and thereafter at intervals. It seems rather surprising, therefore, that if these anomalies cause symptoms early, more cases have not been seen at an earlier stage. Rigid flat foot has been a great rarity at the school clinics in children below the age of ten to eleven. The tarsus in early years is largely composed of cartilage and it is not until the age of eight or nine years that bone fills up this cartilaginous matrix. Slomann quoted Holl of Zuckerhandl's Clinic, who reported the dissection of an infant's foot in which there was a purely cartilaginous bar between calcaneum and navicular. It seems possible that this cartilage may provide sufficient resilience to permit a useful range of movement until ossification converts the bar into a rigid structure. Another interesting point is the condition of the subtalar joint in cases of talo-calcanean bridge. In the cases operated upon the main joint surfaces have possessed normal healthy articular cartilage of normal thickness. It seems doubtful whether this would be the case had the joint been rigidly fixed and functionless since birth. Nevertheless it is admitted that there is probably some restriction in the range of movement in childhood. There is an opportunity here for further useful research in observing the feet of young children with these points especially in mind.

Spasm—For years spasm has been regarded as the main feature of the disability and the term peroneal spasm or spastic flat foot has been used universally as descriptive terminology by intelligent surgeons. For a period, many followed the teaching of Sir Robert Jones in attacking the spasm directly by nerve crush or by tenotomy of tendons. Harris and Beath discounted spasm and practically denied its existence, substituting the idea of adaptive shortening of peroneal tendons. This conception is perfectly true in patients of seventeen years or more, in whom fixed eversion has become established after several years of chronic symptoms. But who is there who has not seen the youngster of thirteen or fourteen years with peroneal tendons, and long extensor tendons too, standing out like bowstrings across the foot, and the relaxation of these tendons that anaesthesia brings? This is not adaptive shortening. It is spasm. The finding in this series agrees with that of Webster and Roberts, who found that spasm certainly occurs in the younger adolescents in acute episodes and that it subsides with rest and physiotherapy. If these attacks of spasm go untreated for any length of time they lead to rapid deterioration of the foot, because continued weight bearing on the strongly pronated forefoot soon causes a breakdown in the long arch and a more severe flat foot than would otherwise have been the case.

Eversion and rigidity—The question why the foot becomes everted and rigid is not easy to answer satisfactorily for both anomalies. It is obvious why the talo-calcanean bridge causes rigidity—because the subtalar joint itself is bridged and fixed. But why should the foot

FIG. 15
Peritalar movement. Heel everted

FIG. 16

FIG. 17

Figure 16—Peritalar movement. Heel in neutral eversion-inversion. Figure 17—Peritalar movement. Heel inverted.

become everted ? Possibly the anomaly is comparable to " sacralisation " of the fifth lumbar vertebra. The case with large overgrowth not only of the transverse process but also of the side of the vertebral body, so that the fifth lumbar body is wedged laterally, is well known.

Possibly a similar mechanism is at work in the foot. This is pure conjecture and is suggested for want of a better explanation.

In the case of the calcaneo-navicular bar the deformity and rigidity are easier to explain. Movement in the subtalar and midtarsal joint (peritalar movement) is a complex one. As pointed out previously (Jack 1953), eversion of the heel is accompanied by an inward swing of the head of the talus, so that a valgus angulation is produced at the midtarsal joint. Conversely, inversion of the heel is accompanied by varus angulation at the midtarsal joint. During these movements the transverse axis of the navicular moves in relation to the transverse axis of the anterior end of the calcaneum, through a range of 15–20 degrees (Figs. 15 to 17). This forms an essential element in peritalar movement. If the navicular is fixed to the anterior end of the calcaneum, this movement is prohibited and therefore there will be obstruction to the valgus and varus movement at the midtarsal joint, and therefore to peritalar movement. When the bar is narrow and has a wide fissure, there may be enough movement between navicular and calcaneum to allow some peritalar mobility. When the bar is large it occupies most of the lateral side of the talo-navicular joint as well as the under-surface. As ossification expands the bar, the talar head gets pushed medially into the valgus position and eversion of the heel automatically results. The larger and more complete the bar, the greater the degree of eversion and ridigity. This corresponds with the clinical findings.

TREATMENT

The management of a case seen in early adolescence has been by a policy of expectancy and symptomatic treatment. When there is no marked deformity and no spasm little may be required beyond periodic observation and the application of heel wedges to the shoes. In patients with an acute episode of spasm and pain, physical rest to the foot either in a plaster (when one foot only is involved) or by rest in bed (when both are affected) has been the policy. Manipulation under an anaesthetic and the application of a plaster in the corrected position has often been advocated, even by Harris and Beath, who have based all their other contentions on the congenital bony nature of the lesion which permits no movement. In this context the case of a patient on whom this treatment was carried out comes vividly to mind. A girl of thirteen was seen with rigid eversion and recurrent spasm of some standing. When manipulation was performed under an anaesthetic the heel came round into the plantigrade position, to the accompaniment of cracks and rending sounds in the supposedly sticky joint capsules and ligaments. The day her plaster was removed the foot was as rigidly everted as before. Operation for triple fusion from the lateral approach revealed the subtalar joint to be firmly fixed—without a degree of movement—by a talo-calcaneal bar; and when manipulation was repeated it was seen that the talus had become partly dislocated from the tibio-fibular mortise. Since that experience, manipulation has not been attempted but plaster has been applied in the position which the foot adopts. If spasm is a prominent element, it will subside just as well from the rest imposed by the plaster, and the original degree of mobility will be regained.

In cases of longer standing, in which deformity is great or disability pronounced, fusion of subtalar and midtarsal joints has been carried out. In cases of calcaneo-navicular bar the deformity can be corrected and fusion performed through the standard lateral approach. But in the presence of a talo-calcaneal bar the operation is difficult through that incision and it has been found much easier to use the medial approach as advocated by Harris and Beath. In this way the bony block to inversion can be excised and sufficient room obtained to excise most of the main subtalar facet and sustentaculum facet, and to excise the surfaces of the talo-navicular joint. The calcaneo-cuboid joint is not fused. The five feet operated on in this way have all been satisfactory both cosmetically and functionally.

No operation to excise the calcaneo-navicular bar has been performed. To have any chance of success excision would have to be carried out very early, and it is not always easy

at that stage to judge what the ultimate condition of the foot is likely to be. Technically the operation is not difficult when the calcaneo-navicular bar is small, but this type often causes little subsequent trouble. The larger complete calcaneo-navicular bar is a formidable structure to excise and its removal theoretically leaves two extensive areas of raw bone in fairly close apposition. Further information on the results of this operation is required before it can be accepted as a standard method of treatment. It is obviously useless to excise the bar once rigid deformity has developed and secondary changes are present in the tarsus. Triple fusion is the only possible line then, and is usually satisfactory provided enough bone is taken away to permit full correction of the eversion and valgus.

NOMENCLATURE

Harris and Beath made a well justified plea for a review of the nomenclature in these conditions so that a more descriptive anatomical indication of the real lesion might be given. It is true that the term peroneal spastic flat foot is insufficient and fails in many ways to indicate cause and effect. It is suggested that there should be three categories. The first includes the bony anomalies. The anatomical description would cover all the various symptomatological phases: 1) talo-calcanean bridge; 2) calcaneo-navicular bar.

The second category embraces those cases without bony anomaly, in which spasm is caused by injury, inflammation, or mild infection—for example, peroneal spasm due to midtarsal trauma, peroneal spasm due to early tuberculous disease of the talus.

A third category embraces those cases seen late as rigid flat feet, and due to a variety of causes—arthritic, rheumatoid, old infection, etc.; for example, rigid flat foot due to atrophic arthritis. This last group does not include rigid flat feet from old established bars or bridges which are grouped in the first category.

SUMMARY

1. Twenty-three cases of tarsal anomaly—talo-calcaneal bridge or calcaneo-navicular bar—occurring among thirty cases of " peroneal spastic flat foot " have been studied.
2. The correlation between the clinical features and the mechanical defect is discussed.

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BERYLLIUM-INDUCED OSTEOGENIC SARCOMA IN RABBITS

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During an extensive experimental study of ultrasound* we learned that such energy can inhibit the growth of bone in animals. Obviously the use of ultrasound on bone tumours presented itself as a potential therapeutic procedure. Since a method for producing such tumours with beryllium was available we endeavoured to produce in rabbits a series of such tumours upon which the effects of ultrasonic energy might be studied. As we proceeded with the work of producing and studying such tumours certain pathological changes were observed, particularly in the spleen, which seemed of sufficient interest to justify a separate report.

This report, then, is restricted to a consideration of pathological changes developing in the organs of the rabbit after intravenous injections of beryllium material. Particular emphasis is given to the pathological changes which accompanied the development of bone tumours, and to the apparent relationship between tumour-genesis in the bones and atrophy of the spleen.

BACKGROUND INFORMATION

Beryllium, a rare metallic element, was discovered by Vauquelin about 1798 and was named glucinum because certain of its salts have a sweet taste. In nature it occurs in combination with other elements. It is a hard, grey metal with an atomic number of 4, atomic weight of 9·02 and specific weight of 1·86. It has become important industrially as a constituent of alloys with copper, aluminium, magnesium, nickel, steel and silver. The alloy known as beryllium-copper is resistant to corrosion, non-magnetic, non-sparking, highly resistant to fatigue and with a remarkably high electrical conductivity. Beryllium is used industrially in precision instruments, non-sparking tools, aeroplane fittings, and electrical equipment, as well as in many other applications. The fluorescent property of certain beryllium compounds has application to the fluorescent-lamp industry.

It is most important that all who use beryllium and its compounds should know the associated toxic effects so that proper precautions are taken when handling them. Unless the great variability in the effects of beryllium and its compounds is appreciated, much confusion may arise when the literature is reviewed. The many factors which contribute to this variability should be kept in mind. The effects of beryllium on experimental animals are twofold: namely, the acute and the prolonged or chronic effects. There seems to be more uniformity among authors with respect to the acute effects than in respect to the chronic effects. Some of the factors that contribute to the variable results reported in the literature are the particle size, state of aggregation, temperature at which the beryllium was processed, solubility of the material used, chemical structure and physico-chemical properties, concentration, dosage and duration of exposure, method of administration, time between the administration and the observations, and the species of animal used in experimental observations.

* Ultrasound is a term used to describe those frequencies in the acoustic spectrum which are beyond the range of the human ear. The standards committee on electro-acoustics (a sub-committee of the American Standards Association) has set the lower limit of ultrasonic frequencies at about 15 kilocycles per second. Ultrasonic waves differ from the familiar audible waves only in frequency and, therefore, wavelength.

Many reports of the toxic effects of beryllium and its compounds have been published by research teams, clinicians and industrial administrators. A complete review is beyond the scope and purpose of this report, and only references pertinent to our particular study with general surveys of the literature will be included.

We are indebted to the late Dr Leroy U. Gardner, whose untimely death in 1946 occurred before he had completed his report. His interesting abstract with Heslington was presented to the Federation of American Societies for Experimental Biology in March of that year. He described for the first time osteogenic sarcoma produced in rabbits by the intravenous injections of zinc-beryllium-silicate and beryllium-oxide. He was the first, too, to recognise splenic atrophy in these animals. George W. Wright published an important paper prepared from Gardner's original notes. Gardner's investigations on bone tumours induced in rabbits by beryllium were confirmed by Hoagland, Grier and Hood (1950) and by Dutra and Largent (1950).

Hyslop and associates (1943) surveyed the literature and gave a comprehensive report of the toxic effects of beryllium as they were known at that time. It is unfortunate that the first sentence of their summary is the one most widely quoted: " The foregoing investigation indicates that beryllium is of itself not toxic." This conclusion was short-lived and it was not confirmed by later investigators.

Scientists at the University of Rochester School of Medicine and Dentistry (Hall *et al.* 1950, Stokinger *et al.* 1950, 1950 and 1953) have been studying the toxicity of beryllium. They have investigated the acute effects on various animals representative of the carnivora, herbivora, rodentia and primates. Thus far they have published studies on a total of eleven species, namely: cats, dogs, chickens, rats, rabbits, guinea-pigs, goats, monkeys, mice, pigs and hamsters. Contrary to the report of Hyslop and co-workers (1943) the group at the University of Rochester stated: "Not only is beryllium unquestionably a toxic agent but it is toxic in such small quantities as to be among the most toxic chemically of all elements yet investigated . . ." They found that quantities of the order of millimicrograms are toxic. Gardner (1946) was curious as to the possibility of some other factor being a trigger-mechanism in association with beryllium, thus producing toxic effects. One such other factor has been shown to be fluorine by the investigators at the University of Rochester (Stokinger *et al.* 1953). They also studied deposition of beryllium in the tissues and its excretion.

Schubert and White (1950) also studied the distribution and excretion of beryllium in adult dogs with the radioactive isotope of beryllium, Be^7. They reported that most of the retained Be^7 was in the skeleton, particularly the long bones, 128 days after injection.

EXPERIMENTAL PROCEDURE

Ten healthy adult male rabbits were selected for our initial study. Five millilitres of a 1 per cent suspension of " zinc beryllium silicate "* was injected through an ear vein twice each week for ten weeks. Thus during that time each animal received 100 millilitres of the suspension, the equivalent of 1 gramme of the beryllium preparation. Since beryllium in the form of its oxide constituted 3·36 per cent of the suspensions injected, each animal received 33·6 milligrams of beryllium oxide.

Throughout the time of the injections and subsequent housing of the animals, the laboratory workers took the greatest care to guard against dangers of berylliosis which has been shown to develop after inhalation of the smallest amounts of this toxic element (experiments elsewhere have shown that beryllium is excreted very slowly through the kidneys). Gloves and masks were worn during the injections, and caretakers were cautioned to keep moist all the litter under the housing cages. Each animal was quartered individually in a

* A 10 per cent suspension of this beryllium preparation was supplied in generous amounts to us by Dr Arthur J. Vorwald, director of the Trudeau Foundation, Saranac Lake, New York, for which we are grateful.

large wire cage and maintained on a metal screen. They were given fresh water daily as well as a standard adequate laboratory ration of food.

After the injection period each animal was examined radiographically once a month until it was evident whether or not osteogenic tumours were developing. Some animals were killed during the early stages of tumour development, whereas others were permitted to progress to a later stage. At death each animal was examined carefully by necropsy. Bones which had shown radiographic evidence of tumour involvement, as well as certain others which did not present such evidence, were removed and fixed in 10 per cent formalin, decalcified and appropriately stained. The spleen, liver, adrenal glands, lungs and all other organs in which metastasis was suspected were removed, fixed and prepared for histological study. The stains used to show changes in the spleen were haematoxylin and eosin, Mallory-

FIG. 1 FIG. 2

Figure 1—Intramedullary sclerosis in the femora of one of the rabbits in which osteogenic sarcoma developed.
Figure 2—Normal medullary cavities in a rabbit in which a tumour did not develop.

Heidenhain stain, and Gömöri's silver-impregnation for reticulum. In some instances an iron stain was used for sections of the spleen. In others, the diphenylcarbazide reaction was employed to demonstrate the presence of beryllium in the tissues. Sections of the adrenal glands were stained with Sudan IV to demonstrate the extent to which lipide had been deposited in the cortices.

RESULTS

All the animals were apparently healthy throughout the experiment. They tolerated all the twenty injections well. They gained weight during the period after injection and were reasonably free of respiratory infection. Some of the animals with advanced tumour involvement showed signs of paralysis of the hind limbs. This may or may not have been related to the extent of the developing sarcomas.

In five of the ten rabbits osteogenic sarcomas were recognised radiographically nine to eleven months after the injection period, the diagnosis being confirmed in each instance by histological section. In the animals in which tumours developed we observed sclerosis in the medullary cavities of the long bones as early as three months after all injections had been discontinued (Figs. 1–3).

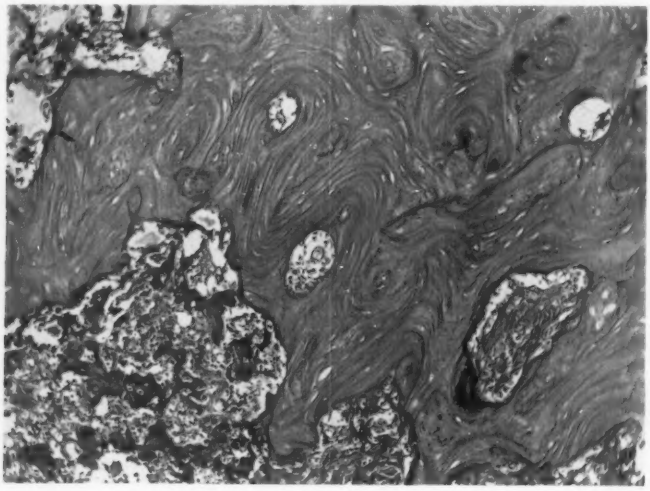

FIG. 3

Section showing new bone as well as early osteoblastic osteogenic sarcoma in the medullary cavity of the right humerus. (Hematoxylin and eosin; ×90.)

FIG. 4

Osteogenic sarcoma in the upper metaphysial region of the tibia.

These osteogenic sarcomas showed a predilection for the metaphysial regions (Fig. 4). Multiple tumours often developed in the same animal. Metastasis to the lungs was not uncommon; and in one animal the lungs were completely infiltrated with a firm osteoid tumour which was obviously a metastatic growth from the primary sarcoma in the femur (Figs. 5 and 6).

The rate of tumour development varied from one animal to another, as might well be expected. The rate of growth was more rapid in some than in others; but the sequence of events, leading to the formation of the metastasising tumour, was similar in all five rabbits. The following is a typical report.

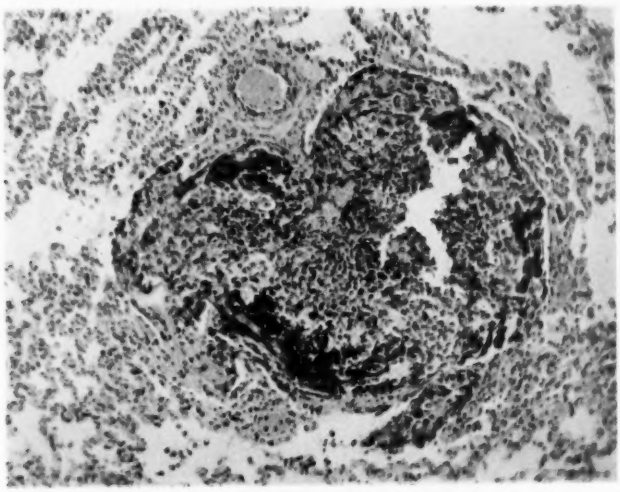

FIG. 5
Pulmonary metastatic growth from osteogenic sarcoma. (Hematoxylin and eosin; ×90.)

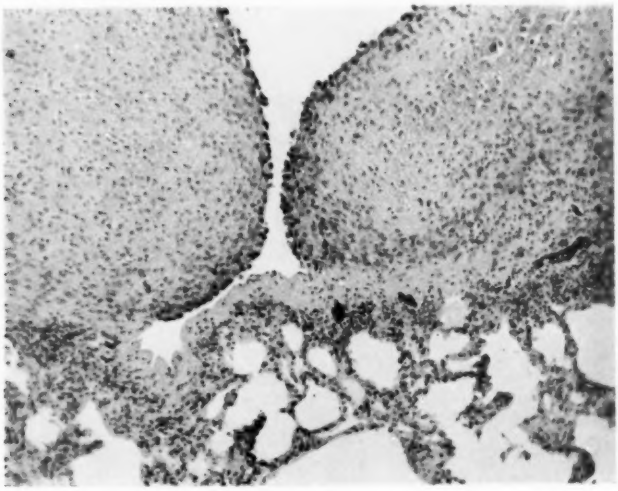

FIG. 6
Two pleural metastatic nodules. (Hematoxylin and eosin; ×90.)

Within six months after all injections had ceased the first obvious change in this animal was the filling in of the medullary cavity of the long bones with a new bone matrix. This was visible in radiographs of the left tibia and right femur. Three months later (nine months after any beryllium had been given) an osteoblastic lesion appeared in the metaphysial region of the upper end of the left tibia, as well as an osteolytic lesion in the metaphysial region of the lower end of

FIG. 7

An osteoblastic lesion in the upper metaphysial region of the left tibia and an osteolytic lesion in the lower metaphysial region of the right femur.

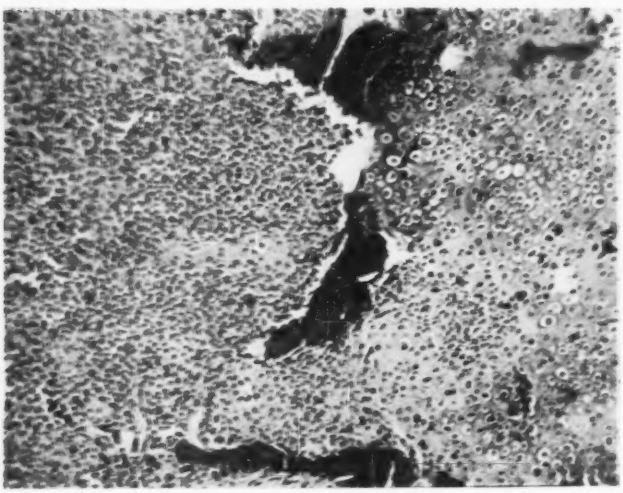

FIG. 8

Chondroblastic sarcoma of the distal part of the right femur. (Hematoxylin and eosin; ×80.)

the right femur (Fig. 7). Microscopic sections from the tumour of the left tibia showed it to be a sclerosing osteogenic sarcoma; whereas sections from the tumour of the right femur showed it to be a chondroblastic sarcoma (Fig. 8). Histological sections prepared from parts of the right humerus which had not shown radiographic evidence of a tumour, showed early changes suggesting the development of an osteogenic sarcoma—there was new bone formation in the medullary spaces as well as fibrosis. In this animal there was also hepatic necrosis and in one part of the liver there was a clearly defined metastatic lesion with osteoid tissue.

Of all the changes observed in the animal just described, as well as in all others in which osteogenic sarcomas developed, the most significant were the marked atrophic changes in the spleen. Gardner and Heslington (1946) had noted splenic atrophy, and Hoagland, Grier and Hood (1950) stated that the spleen was smaller in animals with osteogenic sarcoma. Our studies had led us to believe that there is a definite correlation between splenic atrophy and the formation of a tumour. In all five animals which did not produce bone tumours the spleens were normal despite the fact that the animals had received as much beryllium as those which did produce tumours.

FIG. 9
Spleen of an animal in which the transformation to an aplastic organ was intermediate.

The changes in the spleen induced by beryllium, not only during the time of injection but also during the months leading up to the production of the tumours, were most interesting. A detailed report of this part of our study will be presented elsewhere; it suffices to state here that extreme atrophy occurred in all animals with osteogenic sarcoma—in fact, in some cases the atrophy was so great that all that remained of the spleen was an aplastic fibrotic cord of residual splenic tissue persisting in the gastro-splenic mesentery. Since the fibrotic spleen was largely devoid of circulating blood, the colour patterns had disappeared and the normal deep red was replaced by the white patches of an aplastic organ (Fig. 9). Small areas of functional splenic pulp remained; but the transition to the aplastic condition was obvious. Figure 10 is a section through part of a spleen in which complete atrophy had not yet occurred. The Malpighian corpuscles—the source of lymphocytes—and the reticulo-endothelial components persist; and the red pulp contains large, irregular, concentrated masses of material which the diphenylcarbazide reaction showed was beryllium. A section through the aplastic regions of this spleen (Fig. 11) shows the relatively complete loss of cellular structure. The persistent central artery, and the few remaining lymphocytes, indicate the residue of a Malpighian body. Scattered throughout are a few fibroblasts, a few reticular cells and circulating erythrocytes. When the Gömöri stain was applied to these areas a dense, closely packed, reticular network, embracing all the splenic substance, was shown.

The sequence of events which occurs in these spleens as a result of the injections of beryllium is not unlike that arising from the injection of colloidal preparations or particulate materials. Local histiocytes of the sinusoids and the cords of Billroth first engulf the injected substance which is circulating through the red pulp. These cells increase in size, break down under the toxic influence of the element, and are then destroyed. The Malpighian corpuscles proliferate, increase in size, and release more lymphocytes which migrate into the red-pulp areas, there to transform into phagocytic histiocytes. These newly formed cells engulf the material, only again in their turn to die as a result of toxic reaction. Thus gradually the

cycle of lymphocytes, to phagocytosing histiocytes, to cell-destruction, proceeds until all Malpighian corpuscles are exhausted and the spleen becomes a non-functional aplastic organ, consisting largely of an acellular reticular network.

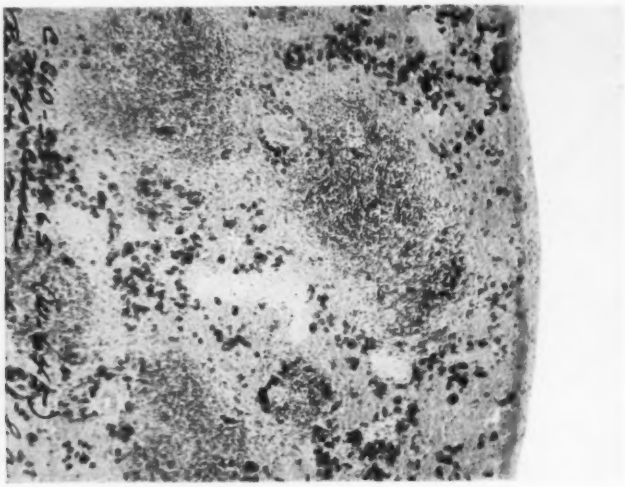

FIG. 10

A portion of the spleen in which complete atrophy had not yet occurred. (Hematoxylin and eosin; ×65.)

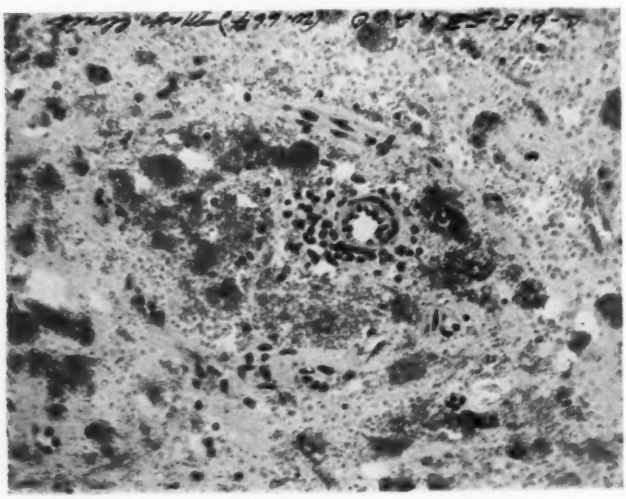

FIG. 11

Section of spleen with relatively complete loss of cellularity. (Hematoxylin and eosin; ×260.)

COMMENT

In this study we have confirmed the observations of previous workers with beryllium, namely that osteogenic sarcomas will develop after a considerable time in some of the animals injected with preparations containing it. Gardner and Heslington (1946) produced tumours

in seven of twenty-four rabbits. Hoagland, Grier and Hood (1950) produced them also in seven of their twenty-four animals; and Dutra and Largent (1950) produced them in six of nine rabbits. We produced osteogenic sarcoma in five of our ten animals. The authors quoted did recognise such splenic changes as reduced size or even atrophy, but little consideration has hitherto been given to a potential relationship between such atrophic or aplastic changes in the spleen and the development of tumours in the bones. Although there is not yet any proof of such a relationship it is notable that osteogenic sarcoma developed in the animals that had an aplastic and obviously non-functional spleen. We propose to explore these relationships in further studies, testing the influences that splenic substances may exert upon the course of induced bone tumours. We are now determining the incidence of beryllium-induced bone tumours in animals which underwent splenectomy before they were given injections of beryllium. If functional splenic tissue does exert an inhibitory influence upon tumour-genesis in the bones, then in such animals from which the spleen has been removed an increased incidence of sarcoma may well be demonstrated.

As a corollary to this concept of an interrelationship between the spleen and bone tumours, we have begun with Dr Warren Bennett of this Clinic a study of the state of the spleen in patients who died of osteogenic sarcoma.

Our original purpose, namely the production by chemical means of osteogenic sarcomas that would serve as test objects suitable for the application of ultrasonic energy, is now being carried out, and the effects of ultrasound on such tumours are still being studied.

SUMMARY AND CONCLUSIONS

The method of producing osteogenic sarcoma in rabbits by the injection of beryllium in the form of " zinc beryllium silicate " is presented. In five of ten animals which had such injections, osteogenic sarcomas developed several months later. There was new bone formation in the medullary cavities of the long bones before malignant changes were apparent. It is of particular interest to note that there was atrophy of the spleen in those animals in which bone tumours developed, whereas the spleen seemed to be quite normal in the rabbits which did not develop bone tumours. The tumours usually developed in the metaphysial regions. More than one tumour often developed in the same animal.

We are indebted to Dr Arthur J. Vorwald, Director of the Trudeau Foundation, for his interest and suggestions concerning the administration of beryllium; and to Dr Friedrich Klemperer of the Saranac Laboratories, Dr Frank R. Dutra of the Kettering Laboratory at Cincinnati, Dr Harriet L. Hardy of the Occupational Medical Service, Cambridge, Massachusetts, and Dr Charles L. Dunham of the Atomic Energy Commission for their advice and suggestions during the early preparations for our study.

We also wish to thank Dr David Dahlin of the Section of Surgical Pathology of the Mayo Clinic for reviewing the histological preparations and confirming the presence of osteogenic sarcoma; Mr Robert Schmit, chief technician of the Section of Pathologic Anatomy, for his help in the preparation of materials for histological study and for identifying beryllium in the tissues; and Mr Glenn Christensen, Mr Sam Amundson, Mr Howard Hanson, Miss Betty Hennessey and Miss Agnes Conger for their technical assistance.

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ARTHROPLASTY OF THE KNEE

Preliminary Report of a New Method

L. G. P. SHIERS, TILBURY, ESSEX, ENGLAND

This is the first of two reports to describe a new method of knee arthroplasty. It represents the end of the first stage, a period of five years of design and experiment to produce a satisfactory prosthesis. The following account describes the prosthesis, its method of insertion, and details of the first two patients operated upon, now over a year ago. It is hoped to publish a second report at the end of a further five years describing a series of cases.

The problem of arthroplasty of the human knee has intrigued surgeons the world over for many years. Since Verneuil in 1860 first suggested the interposition of soft tissue between bone ends to prevent ankylosis a great variety of materials has been used in the elusive search for a substance which, while permitting the bared bone ends to round and develop new cartilage, will not itself abort the operation by initiating suppuration or fibrosis.

It is a far cry from the chromicised pigs' bladders of Baer (1918) to the modern sheets of nylon (Kuhns and Potter 1950), but as in the 'tween years—the years of fascia lata (Putti 1920), the prepatellar bursa (Campbell 1921), fascia lata and fat (Albee 1928), cellophane (Samson 1949) and Vitallium crowns (Campbell 1940)—the only major difference lay in the chemistry of the interposed material; the broad basis of the operation remained the same.

Briefly this consisted in a wide exposure of the joint, removal of the diseased cartilage and bone and the reshaping of a femoral condyle or condyles together with a tibial surface chiselled to receive them.

In 1949 Speed and Trout published a follow-up study of sixty-five such arthroplasties of the knee from the Campbell Clinic, Memphis, analysed as follows:

Results	Cases
Good . . .	29 (44·6 per cent)
Fair . . .	17 (26·2 per cent)
Poor . . .	6 (9·2 per cent)
Failures . .	13 (20·0 per cent)

In 1952 Miller and Friedman analysed the results of thirty-seven cases of knee arthroplasty extracted from the Orthopaedic Service of the State University of Iowa Hospitals, covering the period from 1917 to 1947, with the following results:

Results	Cases
Good . . .	11 (30 per cent)
Fair . . .	8 (22 per cent)
Failures . .	18 (48 per cent)

These results are not good—they are bad.

The knee depends for its stability partly upon the massive muscles that invest it and partly upon a beautiful and complex system of ligaments that arise or are inserted within it.

The attachment of these ligaments is to the cartilage and subjacent bone. It is this very cartilage and bone which is removed as one of the initial steps in arthroplasty; thus the ligaments are removed too and the knee loses stability.

The problem is therefore threefold: 1) to permit flexion; 2) to limit extension at 180 degrees; and 3) to preserve lateral stability.

It is submitted that these criteria can never be really fulfilled by any operation which, while removing the ligaments that performed this duty, omits to replace them with an efficient substitute.

THE PROSTHESIS

This is a hinge. It permits flexion because that is the purpose for which hinges originated. It limits extension at 180 degrees because it has been so designed. It preserves lateral stability because of its large bearing surfaces.

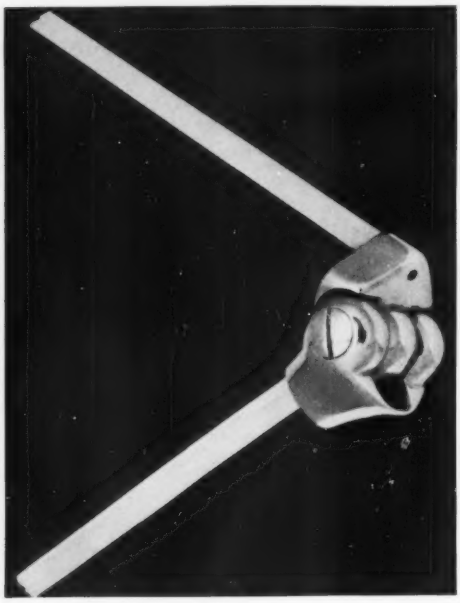

FIG. 1

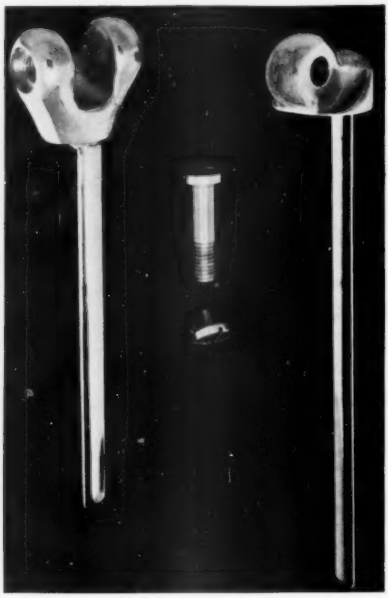

FIG. 2

The prosthesis assembled and in parts.

The hinge, shown in Figures 1 and 2, is made of 18/8 stainless steel, non-electrolytic and reverse plated. Such material causes no resorption of the encircling bone (Collins 1953). It is made in two parts because it is assembled in the knee joint. Each part has a stem, one for insertion in the marrow cavity of the femur, and the other in the marrow cavity of the tibia. The stems are of varying length determined from radiographs before operation; they are screwed into the hinge and then locked. The smallest sizes are designed for the elbow. The smaller screw has a left hand thread, so that, once tightened into the main bearing which has a right hand thread, no amount of flexion or extension can ever loosen it.

INDICATIONS FOR OPERATION

No arthroplasty may be considered successful until it has stood up to at least ten years of normal use; therefore to lay down indications for operation at this stage would be presumptuous. It is merely suggested that if an arthrodesis of the knee be contemplated for instability due to injury, or for pain from osteoarthritis, this method be given a trial. Should it fail arthrodesis can easily be performed—the bone ends are already prepared.

OPERATIVE TECHNIQUE

The patient is admitted ten days before operation and put under the charge of a competent physiotherapist whose task it is to teach and go on teaching the voluntary contraction of the quadriceps mass. The same physiotherapist remains with the patient for the post-operative rehabilitation.

With a tourniquet high up on the thigh, so as to avoid any possible distortion of the quadriceps group, a long, slightly curved incision is made on the lateral side of the knee. It commences at the top of the suprapatellar pouch and, curving to embrace the patella, terminates just below the tibial tubercle. The skin flaps are reflected to their respective sides and the tendinous expansion is divided in the same line as the skin incision. The joint is now open. By inserting two straight fids in front of the femur and beneath the patellar tendon the latter is easily displaced to the medial side and the patella shelled out from below. The continuity of the

FIG. 3

Prosthesis in the knee of a cadaver with a ureteric catheter threaded down the popliteal artery. The vessel is well clear of the prosthesis and moves farther away in flexion.

tendon is not interrupted, a thin pouch being left between the medial and lateral expansions to mark the place where the patella had rested. The expansions may be brought together with two matress sutures to obliterate this cavity and, by inserting them in the long axis of the limb, to reef the tendon. Further gentle leverage on the fids now causes the patellar tendon to slip over the medial femoral condyle. The tibia is flexed and the joint made to yawn widely open. The femoral condyles are removed with a saw. It is useless to nibble; the cut must be firm and bold, removing three-quarters of an inch of femoral bone. The flexed tibia is now pushed backwards, carrying to safety the popliteal vessels (Fig. 3) and permitting the posterior parts of the femoral condyles to be brought into view. These are removed with an osteotome. The uppermost quarter of an inch of the tibial plateau is now sliced off, carrying with it both menisci and the remains of the cruciate ligaments. The lateral ligaments fall back and are spared. Their preservation is of the utmost importance. The flat, raw bone surfaces are thoroughly charred with a ball-pointed diathermy and the field is prepared.

The stem of the female component is hammered gently up the marrow cavity of the femur, it being always remembered that this lies much further posteriorly than one would think. A slow tide of bone marrow, flowing smoothly down the flanges of the stem, is the reassuring guide to the accuracy of the insertion. The male stem is now similarly hammered down the marrow cavity of the tibia; this is much farther forward than one would think.

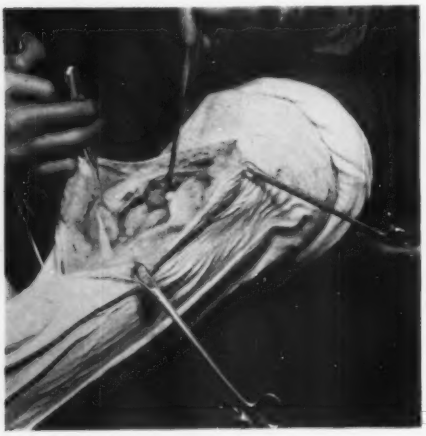

FIG. 4

FIG. 5

Technique of operation. Figure 4—The knee is exposed from the lateral side and, after removal of the patella, the patellar tendon is dislocated medially. Figure 5—Sawing through the femoral condyles.

FIG. 6

FIG. 7

Technique of operation. Figure 6—Femoral part of prosthesis fitted. Figure 7—The two halves in position and assembled.

The tibia is extended, and with a little care the two parts of the hinge are fitted together and the bearing is screwed home. The reverse-threaded locking screw is engaged in the bearing and tightened. As the limb is snapped into full extension the curious finger may feel the lateral ligaments bar taut. The wound is closed and the leg ensheathed in a plaster cylinder for seven days.

The steps of the operation are shown in Figures 4–7.

POST-OPERATIVE MANAGEMENT

The plaster is removed after a week and mobilising exercises are begun in bed. After removal of the skin stitches—usually three to five days later, depending on the patient's rate of healing—the limb is gently flexed to the right angle under Pentothal anaesthesia. Weight bearing with crutches is permitted at the end of a fortnight and progress from then on varies with the patient. The acid test of a knee arthroplasty is coming down stairs. The patient in the second case to be described was able to climb stairs with sticks by the sixth week and to descend with one stick by the seventh.

Physiotherapy is of the utmost importance and the static bicycle plays a large part in rehabilitation, but there is more than this. The patient has a completely new joint, a joint of steel with no terminal sensory nerve fibres. Time must be allowed for an actual cerebral cortical adjustment to take place, as with an amputee. The quadriceps must slowly relax as

FIG. 8 FIG. 9

Case 1. Figure 8—Before operation. Figure 9—Ten weeks after operation. Movement was prevented by excessive new bone formation.

the hamstrings tighten. At first the patient will look down watching the knee, and then suddenly the cortex seems to become readjusted and the rate of progress increases.

CASE REPORTS

Case 1—A woman of sixty-four sought advice for painful osteoarthritis of both knees, the left worse than the right (Fig. 8). Prolonged short-wave diathermy and quadriceps exercises over two years had failed to relieve the pain. Active flexion was through 20 degrees, but pain was the real complaint. It was so bad that the patient requested amputation. Arthroplasty was offered her, it being pointed out that there was no guarantee of its success, but that if it failed she could have an arthrodesis with an inch of shortening. She desired the operation, which was performed in May 1953. In this, the first case, the patella was trimmed and not removed completely—this proved a mistake.

The patient walked well and was soon flexing and extending actively through a range of 70 degrees, but already the radiographs showed increasing new bone formation about the joint.

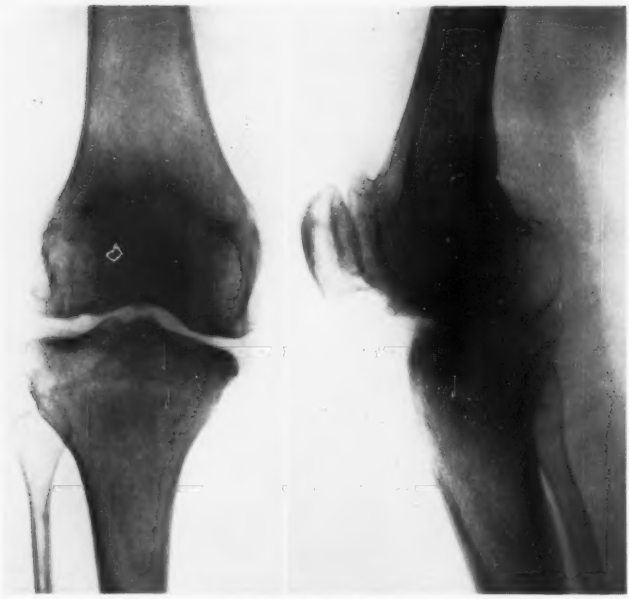

FIG. 10
Case 2—Before operation.

FIG. 11
Case 2—Nine months after operation.

Within two months an inch of bone had grown, the patella was adherent and the hinge was incarcerated in a solid bony coffin (Fig. 9). Flexion was impossible. Arthrodesis was performed and it was observed, once the solid bone had been chiselled away, that a new capsule filled with normal-looking synovial fluid was present and a thin synovial layer was surrounding the prosthesis. There was no trace of any fibrous bands or adhesions.

Case 2—Before this next operation was undertaken enquiries were made as to how bone could be discouraged from growing. It was learned that certain ear surgeons had met a similar problem in the fenestration operation, when new bone grew over their tiny, newly made bony canal. In America this problem had apparently been solved by burring the bony edges with a soft lead burr.

The second case was that of a woman aged sixty-four, with severe osteoarthritis of both knees (Fig. 10). Relief was sought because of constant pain in spite of prolonged physiotherapy extending over twelve months. Operation was performed in September 1953. The range of movement steadily increased. At eight weeks the knee was painless and the patient was walking well with one stick and could walk without a stick. She was able to climb and, more important, descend stairs. In radiographs taken nine months after operation the hinge was seen to have bedded down

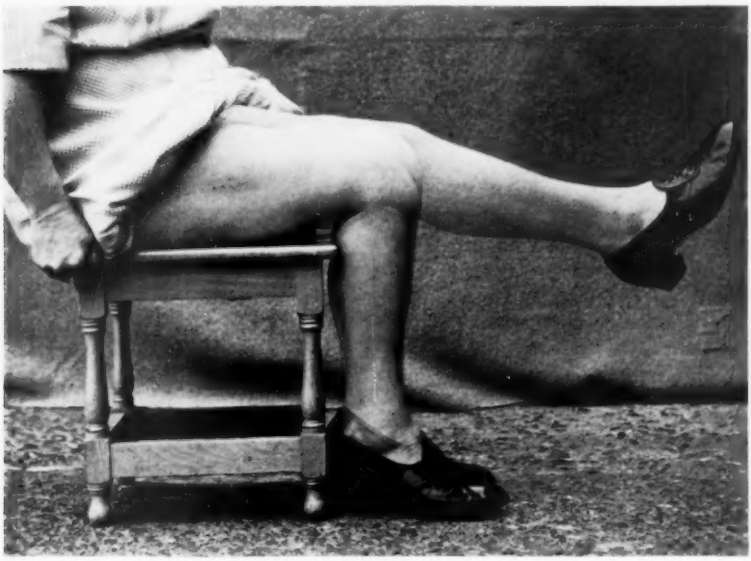

FIG. 12

Case 2—Superimposed photographs showing the range of flexion and extension nine months after operation.

a little (Fig. 11) but there was no evidence of new bone formation and the patient has requested a similar operation on her other knee. Figure 12 shows the range of active movement at nine months.

A further two patients have been operated upon since this paper was commenced. So far they promise well and at three months there is no evidence of new bone formation. It is hoped to include them in the second report referred to at the beginning of this article.

CONCLUSIONS

If conclusions are to be of any value they must be definite and one cannot draw definite conclusions from less than, say, fifty cases followed up for at least five years. However, few surgeons will ever see fifty patients requiring arthroplasty of the knee, let alone operate on them, even in five years. Accordingly, this account of a new approach to the problem of knee arthroplasty is submitted in the hope that other surgeons may care to try it and thereby learn, and thus be able to teach, the modifications and improvements that all new techniques seem so surely to need.

I wish to express my thanks to Mr Raymond King and my brother, Dr Duncan Shiers, who sent me cases, to Mr W. A. Law and Mr H. A. Pearce, who allowed me the use of their hospital beds, to Mr M. A. Gunn and Mr R. Ruddick, who took the photographs, and last, but by no means least, to Mr Guy Drew, of Messrs Down Bros. and Meyer & Phelps, who placed his vast knowledge of metals and prostheses so unreservedly at my disposal.

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ARTHROPLASTY OF THE HIP

A Review of 110 Cup and Replacement Arthroplasties

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From the Middlesex Hospital, London

Cup or replacement arthroplasties were performed on 110 hips in ninety-seven patients* in the orthopaedic wards of the Middlesex Hospital before May 1952. Table I gives details of a review of these cases.

At the present time the value of arthroplasty of the hip is being questioned. It is not only the relative value of different types of operation that is under consideration, but whether arthroplasty is satisfactory in principle. In this paper no attempt is made to subdivide success or failure into degrees, and the results are just recorded as satisfactory or unsatisfactory.

TABLE I

CLINICAL MATERIAL

	Cup arthroplasty (*cases*)	Replacement arthroplasty (*cases*)	Total cases
Seen and reviewed	47	37	84
Now dead	6	5	11
Questioned by letter	5	5	10
Untraced	5	—	5
	63	47	110

TABLE II

RESULTS OF 110 ARTHROPLASTIES (INCLUDING REVISIONS)

	Cup arthroplasty	Replacement arthroplasty	Total
Satisfactory result	50	24	74
Unsatisfactory, or need revision	6	20	26
Deaths attributable to operation	3	1	4
Insufficient information	4	2	6
	63	47	110

But whilst interviewing these patients the matter was gone into in great detail; function, pain, movement and the ability to carry out everyday activities were considered in relation to the individual patient, housewife and breadwinner alike. The opinion of the patient on the result of the operation was also obtained; usually this was given intelligently and often graded the result higher than did the reviewer.

* The records of four others who may have had such an operation cannot be traced, and private patients are not included.

The results were classified as satisfactory or unsatisfactory after taking all factors into account (Table II). Pain and function were considered to be more important than movement. A good arthrodesis of the hip is an eminently satisfactory procedure, with no pain and little disability. An arthroplasty with no pain and some movement is better still and, though the surgeon may be disgruntled, the patient is often well satisfied.

Of the 110 arthroplasties originally performed, twenty were revised and three of the

TABLE III

INITIAL RESULTS OF 110 ARTHROPLASTIES, WITH CAUSES OF FAILURE

	Cup arthroplasty	Replacement arthroplasty	Total
Satisfactory	43	21	64
Unsatisfactory, broken prosthesis	—	8	8
Unsatisfactory, dislocation	3	1	4
Unsatisfactory, painful	11	14	25
Deaths attributable to operation	2	1	3
Insufficient information	4	2	6
	63	47	110

TABLE IV

RESULTS OF TWENTY ARTHROPLASTIES SUBJECTED TO REVISION

	Original operation		Total
	Cup arthroplasty	Replacement arthroplasty	
Satisfactory revision with cup	3	—	3
Satisfactory revision with acrylic prosthesis	2	2	4
Special prosthesis	—	1	1
Successful arthrodesis	2	—	2
Excision of femoral neck, etc.	—	3	3
Unsatisfactory revision with acrylic prosthesis	3	3	6
Death after revision with cup	1	—	1
	11	9	20

latter a second time. The records of most of the patients now dead give sufficient detail to allow the results to be assessed (Table II).

It is evident that, in this series, the outcome of a cup arthroplasty is much more favourable than that of acrylic replacement. In part this can be explained, but not excused, by breakage of the acrylic prosthesis. Table III shows the main causes of failure of the initial operation.

Mechanical failure of the acrylic prosthesis may occur also by erosion of the plastic head or breakage of the skirt (Figs. 1 and 2); in neither case will the damage be apparent on ordinary radiographic examination. Breakage of the stem may in some instances be due to

FIG. 1

FIG. 2

Figure 1—Erosion of the head of an acrylic prosthesis. Figure 2—Less advanced erosion complicated by breakage of the skirt. These changes are not shown on routine radiography.

FIG. 3

FIG. 4

Figure 3—The stem of the prosthesis is too horizontal. Figure 4—The increased mechanical stress caused the stem to break away from the head of the prosthesis.

FIG. 5

FIG. 6

Figure 5—Shortly after cup arthroplasty the femoral neck is of full length. Figure 6—Three years later, the neck has undergone necrosis and has been largely absorbed.

FIG. 7

FIG. 8

Figure 7—Eighteen months after acrylic replacement arthroplasty the patient complained of pain. The radiograph shows crumbling of the femoral neck. Figure 8—Three months later the prosthesis has broken; the boné has disintegrated, leaving no "working stock." A Batchelor arthroplasty was performed.

bad positioning in the femoral neck (Figs. 3 and 4) causing excessive stress, but this neither exonerates the operation nor pacifies the patient.

In cup arthroplasty there is "conservation of working stock." It is true that occasionally there is absorption of the femoral neck (Figs. 5 and 6) but this seems to be unusual. When a cup arthroplasty is revised, the conditions governing the choice of the second operation approximate to those before the arthroplasty. This is not so in acrylic replacement arthroplasties, which, by definition, replace a large part of the head of the femur with inert plastic. Here the choice of operation, should revision be required, is greatly limited, especially if the femoral neck has crumbled (Figs. 7 and 8). The results of the operations for revision in this series bear out the essential difference between the two operations, as is shown in Table IV.

The four revisions using cups and three of the successful revisions using acrylic prostheses were done over two years ago. The fourth successful acrylic revision was reviewed after

TABLE V

DIAGNOSIS AND RESULT OF INITIAL ARTHROPLASTY IN 110 HIPS

	Cup arthroplasty		Replacement arthroplasty		Total	
	Total	Satisfactory	Total	Satisfactory	Total	Satisfactory
Osteoarthritis . .	46	31	34	16	80	47
Recent fracture . .	—	—	11	4	11	4
Ankylosing spondylitis	8	7	—	—	8	7
Congenital dislocation .	7	4	1	1	8	5
Other conditions .	2	1	1	—	3	1
	63	43	47	21	110	64

thirteen months. Three of the unsatisfactory acrylic revisions have had a second revision; two remain painful with respectively a metal and an acrylic prosthesis, the third is undergoing arthrodesis.

The diagnosis before arthroplasty is of great importance in assessing a result. A result regarded as successful in a patient with ankylosing spondylitis could well be a failure in osteoarthritis. Table V summarises the main diagnostic groups with the results. It will be seen that the treatment of recent fractures of the femoral neck has not been particularly successful.

No assessment could be made in two cases of recent fracture and three of osteoarthritis (treated by cups) owing to insufficient information.

Arthroplasty for ankylosing spondylitis is usually considered to give a bad result. In this series three of the five patients had bilateral operations. Apart from one who could not be traced, all were satisfactory. Although movement was not good, none could walk more than a mile, and some had pain, nevertheless all showed considerable improvement in function as a whole, and all were pleased with the operation.

The average age of the patients shows a considerable difference for the two types of arthroplasty: for cup arthroplasties it was forty-nine years, and for acrylic replacements sixty-three years. This is in part due to the elderly group of recent fractures in the acrylic series (average age seventy) and the young group of ankylosing spondylitis (average age twenty-eight) in the group treated by cups. The average age of patients with osteoarthritis

treated by cups was fifty-two, and of those with acrylic prostheses sixty-two. Apart from this there was no obvious association between result and age.

The mortality in this series has been high. Ninety-seven patients underwent 133 operations and four died. Two died of pulmonary embolism which was demonstrated at post-mortem to have originated in one case in the posterior tibial vein of the opposite limb, and in the other in both popliteal veins. In the third patient there was massive collapse of both lower lobes of the lung, with fat embolism. The fourth died the day after operation; there was no necropsy, but a diagnosis of coronary thrombosis with peripheral failure was made by a cardiologist and there was a history of coronary disease.

There is a considerable difference in the length of follow-up of the two operations performed in this series; almost all of the cup arthroplasties were done between 1947 and 1950, and the acrylic replacements from 1950 to 1952.

DISCUSSION

The results in the entire series of arthroplasties are discouraging. But when the series is divided according to the two types of operation it is found that cup arthroplasty yielded results regarded by the patient, as well as the surgeon, as satisfactory and worth-while in five patients out of six; with acrylic prostheses, no more than half come into this category. The mortality has also to be taken into consideration.

There seem to be two main reasons for the difference between the results of the two operations. The first is the mechanical failure of the acrylic prosthesis, and the second the conservation of the living bone in the cup arthroplasty. Because of the latter, revision of a cup arthroplasty is not a great problem. It is just the opposite with acrylic replacement arthroplasty, especially when revision is necessitated by breakage of the stem of the prosthesis with crumbling of the femoral neck. It is true that this may be a result of an error in the technique of insertion: the easier an operation is to do, the easier it is to do badly. The convalescence is quick and the early results after operation gave rise to great hopes. It is not surprising that, with long waiting lists, the operation became popular, perhaps a little too quickly.

The place of each operation will in time be established. Mechanical mishaps due to faulty manufacture can be eliminated and the technique of the insertion of the acrylic prosthesis will be better understood. Until that time comes it seems from these results that cup arthroplasty can be regarded as a reasonable procedure and preferable to acrylic replacement.

SUMMARY

All the cup and replacement arthroplasties of the hip at the Middlesex Hospital performed two or more years ago—110 cases—have been reviewed. Cup arthroplasty was the more successful.

I wish to thank Mr Philip Wiles for his very great help and advice in preparing this report, and also for his and Mr P. H. Newman's permission to publish these findings. I am also very grateful to Mr J. W. Dickson for his assistance in reviewing the patients.

A REVIEW OF 650 HIP ARTHROPLASTY OPERATIONS*

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This paper presents an analysis of the results obtained in cup arthroplasty and Judet arthroplasty of the hip by members of a research group of the British Orthopaedic Association.

CLINICAL MATERIAL AND METHOD OF ANALYSIS

The investigation has covered much ground, 649 hips having been examined from seven centres. The post-operative periods mostly range from six months to six years, but in fourteen cases it was between six and eleven years.

Of the 649 cases 157 were from two centres. Excluding seven who had died this represents 98 per cent of all the patients operated upon there during the period under investigation. Only one patient in this group died as a result of the operation. In the opinion of the statistician, a comparison of the results obtained from this very complete series and the remainder justified the whole 649 being used for analysis.

For an estimation of the comparative values of operations some method of assessment of end-results must be used. In general terms, arthroplasty of the hip is performed to relieve pain, and to give the patient a useful, movable joint which will remain more satisfactory than the one he possessed before the operation. The method of assessment employed takes into account the pre-operative and post-operative pain, the post-operative range of movement, the patient's own valuation, and particularly the use of the hip by the patient in ordinary everyday activities before and after the operation (Shepherd 1954). Results are classified as "excellent," "good," "fair" and "poor." *Excellent* and *good* are more or less self-explanatory. Broadly speaking *fair* indicates that the patient's condition has been improved, and that the operation was worth doing, whereas *poor* implies that there has been deterioration from the pre-operative condition, either in pain or function, or more usually both, or that there has been failure to obtain more than a trace of movement.

Many analyses have been undertaken, and all the statements made here are supported by figures whose statistical significance has been verified.

Some of these analyses confirm results well established by ordinary clinical experience. For example, so far as diagnosis influences the result, better results are obtained in osteoarthritis than in rheumatoid arthritis; a good result is rare in protrusio acetabuli; a result that would be only fair in osteoarthritis is very satisfactory in ankylosing spondylitis; a hip ankylosed after an earlier infective arthritis tends to re-ankylose after an arthroplasty.

RESULTS

Table I shows the results under the various diagnostic headings, in actual numbers. Seven cases with double diagnoses are excluded.

Under the heading osteoarthritis are included so-called idiopathic osteoarthritis, and osteoarthritis secondary to Perthes' disease and slipped epiphysis. Many cases labelled idiopathic are probably secondary to congenital disproportion and a few even to mild subluxation. At a late stage it is impossible always to distinguish with certainty the underlying cause, but the problems presented throughout the "osteoarthritis" group are similar.

The best results are found when only one hip is diseased and is operated upon, less good

* Paper read at the meeting of the British Orthopaedic Association at Buxton, May 1954, and based on the work of the British Orthopaedic Association Research Group on arthroplasty of the hip. A preliminary communication on this work appeared in the August 1954 issue of this Journal.

TABLE I

DIAGNOSES AND RESULTS (642 CASES).

Primary condition	Result				Total
	Excellent	Good	Fair	Poor	
Osteoarthritis	61	100	116	127	404
Fracture or dislocation	9	13	14	8	44
Protrusio acetabuli	1	2	2	8	13
Congenital subluxation	9	7	21	17	54
Congenital dislocation	4	6	11	7	28
Infective arthritis	1	7	9	13	30
Rheumatoid arthritis	2	6	12	6	26
Ankylosing spondylitis	1	12	14	16	43

TABLE II

RESULTS FOR ALL ARTHROPLASTY OPERATIONS ACCORDING TO HIP INVOLVEMENT

(In percentages)

	A Double	*B* 1 and 1	*C* Single
Excellent	6	14	19
Good	23	24	24
Fair	31	31	31
Poor	40	31	26
Total numbers	205	146	298

A Both hips—bilateral operation. *B* Both hips—unilateral operation. *C* Single hip

TABLE III

RESULTS IN RELATION TO AGE IN CASES OF CUP ARTHROPLASTY PERFORMED FOR OSTEOARTHRITIS

Age (*years*)	Excellent or good (*per cent*)	Fair (*per cent*)	Poor (*per cent*)	Total (*numbers*)
40–50	55	25	20	51
50–60	43	31	26	148
60–70	42	28	30	108
70–80	40	20	40	15
All ages*	40	29	31	341

* Includes 19 patients under 40 years of age.

when both are diseased and one is operated upon, and least good when bilateral operations are performed for disease of both hips (Fig. 1; Table II). The bilateral operations show the lowest percentage of *excellent* results, and the highest of *poor* while the reverse is true in cases of single hip affection. The bilateral affection with single hip operation occupies an intermediate position throughout.

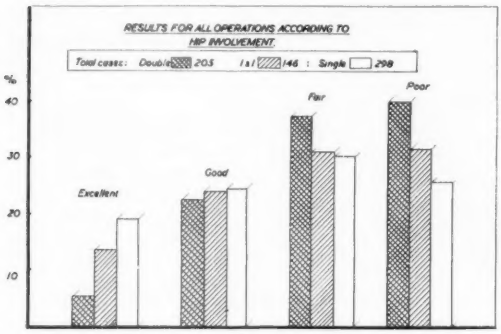

FIG. 1

Results compared in cases of bilateral arthroplasty, bilateral disease with unilateral arthroplasty, and unilateral disease.

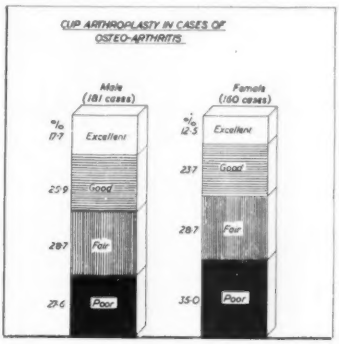

FIG. 2

Comparative results of arthroplasty in men and women.

This does not mean that bilateral operations are inadvisable. In fact if one could pick out the most successful case of the whole series, at the time of the examination, it would probably be that of a farmer who had had bilateral cup arthroplasty operations performed for osteoarthritis. But the knowledge that less good results are likely to be obtained when bilateral operations are performed (40 per cent poor in this series) calls for more discrimination in the selection of cases than in the single hip affection.

Effect of age and sex—The effect of age on the results of cup arthroplasty performed for osteoarthritis is in accordance with clinical observation (Table III). Although many old people obtain excellent results, there are fewer *excellent* and *good* results among the older patients and a higher percentage of *poor* results.

TABLE IV

RESULTS IN CASES WITH FLEXION DEFORMITY. CUP ARTHROPLASTY (509 CASES)

(In percentages)

	Flexion deformity in degrees				
	None	0–10	10–20	20–30	30–40
Excellent or good	42	48	31	17	9
Fair . . .	31	27	30	33	33
Poor . . .	27	25	39	50	58
Total . .	370	48	61	18	12

Rather surprisingly, sex appears to have an effect on the results (Fig. 2). The fact that the women gained fewer *excellent* results and more *poor* ones than the men is possibly explained by the selection of cases, and by the better level of muscular fitness of the men.

Effect of flexion deformity—An unexpected finding, noted during the clinical examinations, and confirmed in analyses, was that better results were often seen when there was

some degree of permanent flexion deformity after the operation (Fig. 3; Table IV). The analysis of the 509 patients subjected to cup arthroplasty shows that those with a flexion deformity up to 10 degrees have better results than those without any deformity. Even when the deformity amounts to between 10 and 20 degrees 31 per cent fall into the category of *excellent* or *good*. Since many of these were probably among the worst cases originally, this seems significant.

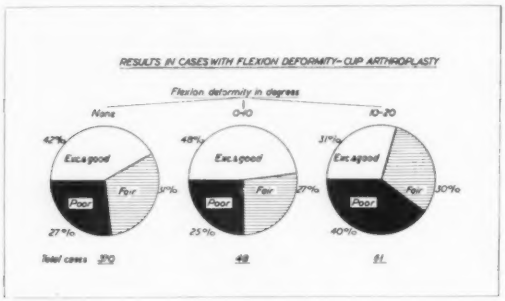

FIG. 3

Results of arthroplasty correlated with the degree of fixed flexion deformity.

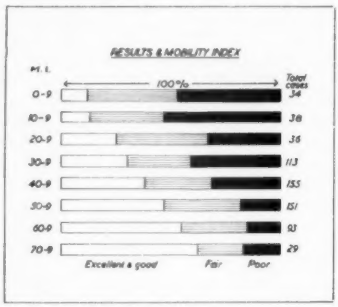

FIG. 4

Results of arthroplasty correlated with Gade's mobility index.

Movement—The correlation of the range of movement and the category of result is particularly interesting. In assessing movement I have used Gade's method, which expresses all the active movements of the hip in one figure, the mobility index. This is not merely a summation of movements, but an indication of function in that it is an expression of the most important ranges of all active movements, and the extremes of movement count little. A mobility index of 100 represents full movement in a young adult's hip; 50 is just under half that range, a hip with such an index having perhaps 80 degrees of flexion and 15 degrees of

TABLE V

RESULTS RELATED TO RANGE OF MOVEMENT (GADE'S MOBILITY INDEX)
ALL CASES. (In percentages)

	Mobility index							
	0–9	10–9	20–9	30–9	40–9	50–9	60–9	70–9
Excellent or good	12	13	25	30	38	47	55	62
Fair . . .	41	34	42	29	31	35	30	21
Poor . . .	47	53	33	41	31	18	15	17
Total . .	34	38	36	113	155	151	93	29
				268		244		

abduction as the main movements. Most reconstructed hips in this series showed mobility indices between 30 and 70 (Fig. 4; Table V).

Figure 4 shows the results for all cases according to the mobility indices in tens. The *excellent* and *good* cases increase steadily with increase in the mobility index. The *poor* cases, although on the whole showing a decrease with increasing indices, show two peaks, with mobility indices between 10 and 20, and 30 and 40, and a tendency to rise between 70 and 80.

The interpretation of these findings is not immediately obvious, nor is it made easier when the average mobility indices for the four categories of results are considered (Fig. 5). There is not a great deal of difference between the average mobility indices in the *excellent* and *poor* groups.

AVERAGE MOBILITY INDEX IN THE VARIOUS GRADES

ALL CASES

Excellent	Good	Fair	Poor
52	49	45	40

FIG. 5
Average mobility index in the four categories of result.

The importance of stability—I became impressed more and more, as the clinical part of the investigation proceeded, by the value to the patient of stability and control of the joint. A patient must be unconsciously confident of the reliability of his hip in order to use it. Patients expressed their lack of confidence in several ways. "I'm afraid to cross the road alone"; "Now I need two sticks whereas before, although I limped, I did not need any"; "I'm unsure of myself, especially after sitting some time"; "The pain is less, but I'm more helpless now."

Here, in the realisation of the importance of stability, is at least part of the explanation of some of the findings. Results were found to be a little better in the group of patients with slight flexion deformity. In the case of a patient who has, for example, some flexion deformity before operation, there has been for a considerable time a slow change in the muscles about the joint, particularly marked in the short muscles close to the joint, resulting in alteration in length and direction of pull. A wandering acetabulum, subluxation, or dislocation must have considerable effect on these muscles, some possibly taking on a sling-like function, acting more as ligaments than muscles. If, during operation or shortly afterwards, correction of the deformity is carried beyond a certain point, some muscles may be overstretched, others slackened. In either case the affected muscles are rendered less capable of performing their main function, that of stabilising the joint. The longer muscles, whose main purpose is movement, are affected only slightly, and their capacity to function may be but little impaired. Nevertheless for the muscles with the longer leverage to work well, the shorter muscles must hold the fulcrum steady.

This conception of the importance of stability and the cause of instability can also help to explain the relationship between the amount of movement obtained and the category of result (Fig. 4). With a mobility index over 40, *excellent* and *good* results outnumber the *poor* results—increasingly so up to a mobility index of 70.

Range and power, and control, are undoubtedly all connected. Yet the average mobility index for the *poor* case is not so very much less than for the *excellent* case. When the patient is in the recumbent position on the examination couch, and when there is no mechanical block to movement, the long muscles may have sufficient power to produce a good range of active movement although the small muscles are not playing their full part. Their inefficiency becomes evident on weight-bearing activity. A wide range of movement without stability does not give a good result. With a mobility index between 10 and 20 the percentage of *poor* results is at its greatest, whereas with one below 10 it has decreased. This, I think, is due to the fact that below 20 muscle control is feeble, but that below 10 stability is being secured by other means than muscular action. The relative parts played by movement and control in

securing a good result may also explain the low incidence of poor results at a range of 20-30, and the peak incidence at 30-40.

Effect of transplantation of the greater trochanter—Another analysis, of cases with and without trochanteric transplantation, appears to confirm the importance of the attainment of stability. Since the posterior incision was used in most of the cases in which the trochanter was transplanted, it is of value to compare the results of the two commonest surgical approaches (Table VI). The posterior incision gave a higher percentage of *excellent* and *good* results, but also a higher percentage of *poor* results. In the Table the results are not broken up into periods of post-operative time.

TABLE VI

RESULTS IN CUP ARTHROPLASTY ACCORDING TO THE INCISION USED
(In percentages)

Result	Incision	
	Anterior	Posterior
Excellent or good .	40	44
Fair . . .	32	24
Poor . . .	28	32
Total numbers .	339	91

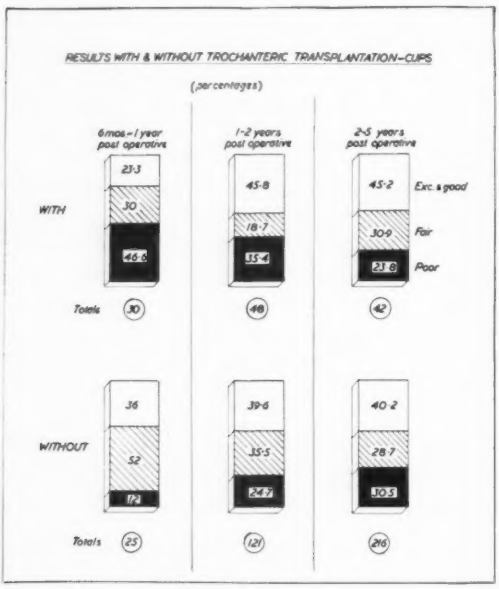

FIG. 6

Results of arthroplasty with and without transplantation of the greater trochanter.

When cases with and without trochanteric transplantation are shown in terms of periods of post-operative time the results are interesting (Fig. 6). In this diagram the upper blocks represent cases in which the trochanter was transplanted and the lower those in which it was not. The early results, up to one year, were better when the trochanter was not transplanted. The results at 1-2 years included a higher percentage of *excellent* and *good* cases when transplantation was performed, but also a higher number of poor cases. Later, 2-5 years after operation, the better results are seen in the cases with transplantation. Selection of the cases in which the trochanter is transplanted must be considered in an explanation. When the posterior incision with detachment of the greater trochanter is the method of approach, and the shortening has been minimal, the detached trochanter cannot be transplanted, and is replaced. These are obviously cases that are going to do well so far as stability is concerned. In other cases, in which the amount of shortening is sufficient to allow transplantation, this corrects the tension of the abductors, but cannot affect the other short muscles.

The significance of upward and medial displacement—Slackening of the abductor muscles, gluteus medius and minimus, is caused mainly by an upward displacement of the femur, while the pyriformis, obturators, gemelli, and quadratus femoris are affected by medial

TABLE VII

RESULTS IN TERMS OF INTERVAL SINCE OPERATION. CUP ARTHROPLASTY (526 CASES)

(In percentages)

	Years since operation					
	½–1	1–2	2–3	3–4	4–5	5–11
Excellent	9	17	13	13	10	11
Good .	20	24	24	32	19	12
Fair .	40	31	32	27	19	23
Poor .	31	28	31	28	52	54
Total .	55	169	127	98	42	35

displacement. Upward movement unaccompanied by medial displacement may even stretch these muscles so that they act at an advantage. This may be the case in congenital dislocation or subluxation of the hip when a marked Trendelenburg gait is not associated with insecurity. Tightening of the abductor muscles by shifting their insertions distally does not affect the slackened transverse muscles, which require a considerable time to adapt themselves. Rehabilitation does occur, and after two years or so it appears that transplantation has been of benefit.

The early good results of the Judet operation are probably in part due to the fact that

TABLE VIII

RESULTS IN TERMS OF INTERVAL SINCE OPERATION. JUDET ARTHROPLASTY

(In percentages)

	Years since operation		
	½–1	1–2	2–3
Excellent . . .	16	16	11
Good	22	28	32
Fair	37	26	19
Poor	25	30	38
Total	32	43	37

there is little or no shortening, and, therefore, little or no slackening of the stability muscles. In the valgus position of the prosthesis dislocation is more likely to occur. The ball and socket is as well constructed as when the prosthesis is in the normal or varus position, and the transference of the line of the body weight nearer the midline of the body should be an advantage; but the short transverse muscles are slackened by this shift, and cannot hold the head securely in the acetabulum. An interesting observation by Mr Sharrard may be quoted

here. This is that in cases of poliomyelitis in which the small lateral rotator muscles of the hip alone are paralysed dislocation of the hip is not uncommon.

From all this it seems that there might be an advantage in the use of a cup with a thickened dome.

Durability—Table VII and Figure 7 show the results of cup arthroplasty operations in terms of the time since operation. It will be seen that the results are at their best after one year and up to four years after operation, but that at four to five years the *poor* results have risen to 52 per cent, and beyond five years to 54 per cent. Table VIII shows the corresponding analysis in cases of Judet arthroplasty, and Figure 8 compares them with the cup arthroplasties. The results of Judet arthroplasty are good up to two years, and in the period from six months to one year they are better than those of cup arthroplasty. But the 2-3 year group shows an increase in the *poor* results, which have risen to 38 per cent. A more detailed analysis of an over-two-year group of 79 Judet arthroplasties with an average follow-up period of thirty-one months shows that the 2½-3 year group is less good than the 2-2½ year group. This suggests that increasing deterioration is likely with the passage of time.

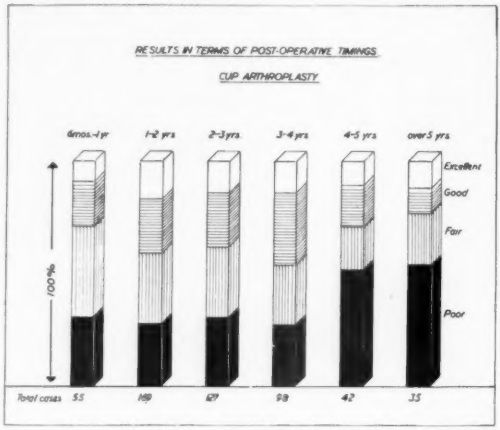

FIG. 7

Results of cup arthroplasty correlated with the time since operation.

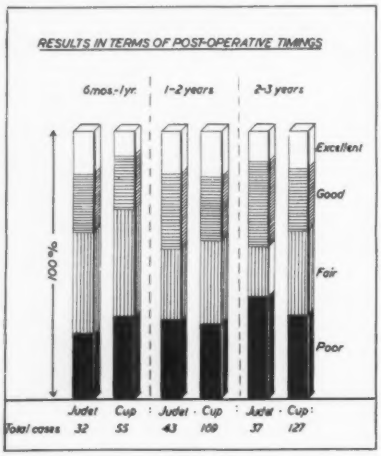

FIG. 8

Results of cup arthroplasty and Judet arthroplasty correlated with time since operation.

To obtain these seventy-nine cases I have combined figures from two hospitals. These hospitals had, together, 111 cases in which operation had been carried out two or more years previously. Thirty-two patients had no over-two-year record. In forty-two cases the notes and radiographs gave an indication of the condition of the patient two or more years after operation. These were classified as "satisfactory," "doubtful" or "unsatisfactory." Thirty-seven of the patients were seen and assessed as before. Table IX records the results in these seventy-nine cases of Judet arthroplasty followed up for over two years, and Table X shows the primary condition necessitating operation.

The high percentage of *poor* results in the over-two-year group of Judet operations and the over-four-year group of cup arthroplasties is at first sight depressing. But these same lists show 43 per cent and 29 per cent respectively of *good* and *excellent* results, and many of these show no sign of deterioration. Considering the nature of the conditions for which these operations were undertaken, and the increasing age of the patients, these good results should not be overlooked.

Although in this series I have only examined sixty patients other than those with cup

or Judet arthroplasties my impression of the durability of arthroplasties as a whole is that the most durable are those in which no foreign material is introduced into the joint; the next most durable are those in which a foreign body is interposed between the joint surfaces; and the least durable results follow attempts to incorporate a foreign material in one of the bones of the joint.

TABLE IX

RESULTS OF SEVENTY-NINE JUDET ARTHROPLASTIES OBSERVED FOR MORE THAN TWO YEARS

Number of cases			Percentages		
	Years since operation			Years since operation	
	2–2½	2½–3		2–2½	2½–3
Excellent	2	2	Excellent, good or satisfactory	42	27
Good	6	6			
Fair	2	6			
Poor	3	10	Fair or doubtful	26	21
Satisfactory	5	5			
Doubtful	6	4	Poor or unsatisfactory	32	52
Unsatisfactory	7	15			
Total numbers	31	48			

TABLE X

PRE-OPERATIVE DIAGNOSIS IN SEVENTY-NINE PATIENTS TREATED BY JUDET ARTHROPLASTY

Diagnosis	Number of cases
Osteoarthritis	48
Rheumatoid arthritis	1
Congenital subluxation	8
Congenital dislocation	1
Protrusio acetabuli	2
Recent fracture	3
Old fracture	12
Infective	3
Unknown	1

DISCUSSION

Apart from error in the selection of cases, and operative or post-operative "accidents," the main causes of failure to achieve satisfactory results are inability to maintain movement in the joint, instability, or the appearance or reappearance of osteoarthritis. Gradual decrease in the range of movement, fixed deformity, or even fibrous or bony ankylosis may occur.

FIG. 9

FIG. 10

Figure 9—Late result of arthroplasty in a man of thirty-four operated upon for osteoarthritis. Despite the false joint between neck and acetabulum the clinical condition was satisfactory. Figure 10—Arthroplasty for ununited fracture of neck of femur. Result satisfactory despite impingement of neck on acetabulum.

FIG. 11

FIG. 12

Figure 11—Pseudarthrosis between femoral neck and acetabulum after arthroplasty for osteoarthritis. Figure 12—A similar condition after arthroplasty for fractured neck of femur. In both these cases the result was unsatisfactory.

Instability may result from the operation and be of such a degree that it persists. Lack of adequate rehabilitation may cause the unnecessary persistence of even lesser degrees of instability. Absorption of the neck of the femur or the floor of the acetabulum may later bring about the same condition. Loosening and increasing varus of the prosthesis in a Judet arthroplasty again results in instability.

The apparently capricious appearance of osteoarthritis is a cause of many disappointing results. Among the seventy-nine Judet arthroplasties examined there were four cases in which weight bearing was shared by the bone of the neck and the prosthesis. In two of these a pseudarthrosis had formed, and worked in harmony with the arthroplasty; the false joint showed no clinical or radiological sign of osteoarthritis, nor did any deterioration occur during eighteen months of observation. The first of these patients was a man of 34, with the pre-operative diagnosis of osteoarthritis (Fig. 9). The other was a woman of 61, whose pre-operative condition was osteoarthritis secondary to avascular necrosis complicating a fracture of the neck of the femur (Fig. 10). In only two other cases in the series of seventy-nine, had the neck shared the weight-bearing. Strangely, these two patients were of similar ages to those just described and their pre-operative condition was similar. One was a women of 43 with bilateral osteoarthritis (Fig. 11). The other was a women of 61 with an old fracture of the neck of the femur (Fig. 12). Two and a half years and two years, respectively, after operation the clinical condition of both was unsatisfactory, and there was radiographic confirmation of the development of osteoarthritis in the pseudarthrosis.

Two cases, one of " excision of the hip " and the other " arthroplasty with interposed pad of fat," which I saw have achieved and maintained very good results. They have been excluded from this series because they had been done so much longer than the others (both more than twenty years ago, by Mr Sampson-Handley and Mr Bankart respectively).

If we could answer the question " Why do some arthroplasties succeed while others fail ? " it would be much easier to decide what to do for patients with severe hip affections. It is possible that for some conditions hitherto treated by arthroplasty a better procedure will be found. In many cases, however, the ideal is a relatively painless, stable, durable, and movable joint such as is the aim of an arthroplasty. This result has been achieved many times. Disappointingly often, it has not. But, with increasing knowledge of the causes of failure and the reasons for success, it should be possible to decide on the best method of treatment in individual cases, to secure a much higher proportion of good results, and even to give the patient a confident and reliable prognosis.

I should like to thank all the surgeons who joined in the research for their help, advice and encouragement; and the nursing and administrative staffs of the hospitals concerned for the extra work entailed. For assistance in printing the proformae, the production of tables and statistics, and for drawing the diagrams for this paper I owe much to Mr T. E. Cowan, the statistician at the Middlesex Hospital.

This investigation was carried out with the aid of a grant from the Oliver Bird Fund of the Nuffield Trust.

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OSTEOMYELITIS IN THE NEW-BORN

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In recent years a number of cases of osteomyelitis in the new-born have been recorded, the disease affecting the long bones. It is probable that the number of cases coming under treatment will increase as a result of the successful treatment of septicaemia in the new-born by means of antibiotics. This paper reviews recorded cases and adds six more.

Dillehunt (1935) stated that in the records of the previous eighteen years he had been able to find only one case of osteomyelitis occurring in a long bone in an infant. Madier (1922) described a case of osteomyelitis in a vertebra in a child of three weeks. Fraser (1924) reported twenty-four cases of osteomyelitis secondary to umbilical sepsis, and stated that the outcome was invariably fatal. This view was substantiated by the experience of Dunham (1933), who found osteomyelitis in 10·3 per cent of cases of septicaemia in the new-born, three out of four of these cases having a fatal termination. Mount (1935) reported a fatal case of osteomyelitis of the humerus occurring in the course of septicaemia. Green (1935) recorded a case of osteomyelitis of the humerus at the age of two weeks with recovery. The bone infection was probably secondary to a furuncle of the cheek. Green and Shannon (1936) reported twenty-three cases of osteomyelitis in children under the age of six months, of whom ten died. They stressed the importance of skin infection and umbilical sepsis as the primary focus.

Dillehunt (1935), describing three cases in young children, one of which was in the neonatal period, wrote: " The disease is rare in infants. It is relatively benign and neglect to treat it is less harmful than in adults. The prognosis is favourable. Sequestra do not form. Spontaneous resolution without treatment may occur. Foci of infection may become sterile." He noted that the children suffered little constitutional disturbance in one case despite multiple foci of infection in the long bones. Resolution occurred rapidly after simple drainage. Cass (1940), who described three cases, also remarked on the absence of systemic disturbance; and Stone (1942), describing four cases, in all of which the child recovered, stated that the course was benign and that treatment of the bone lesion was of secondary importance. He added that the prognosis with regard to life and function was good. The views of Fraser and Dunham, therefore, conflict with those of Dillehunt, Cass and Stone.

Einstein and Thomas (1946) reported ten cases of osteomyelitis in infants, one of which occurred in the neonatal period. They agreed with Cass about the prognosis for life, but noted that the prognosis for function was not so good, because involvement of joints was common. Shulman (1946) reported a case in a child of nineteen days. The bone infection was secondary to septicaemia, and it was complicated by destruction and dislocation of the hip joint. The child survived, but there was serious functional disability from destruction of the hip.

It seems from the records quoted above that there are two types of case: one in which osteomyelitis occurs during a severe septicaemia which threatens life, and a second in which there is little systemic disturbance even despite multiple bone lesions. This division into two groups was well illustrated by Greengard (1946) who described ten cases in children, one in the neonatal period. Hutter (1948) described three cases and agreed with Greengard's classification.

Osteomyelitis in these young children differs in its progress from the same condition in the more common age group, especially in the rarity with which massive necrosis and

sequestration occur. An explanation for this difference was suggested by Green (1935). As in all cases, the infection begins in the metaphysis, which, in the new-born, contains very little cortical bone. The cancellous bone is soon penetrated, with escape of pus to the subperiosteal area. The periosteum in these young infants is easily stripped up from the bone, so early decompression is effected. This process is further augmented by relatively easy penetration of the periosteum, allowing the escape of pus beneath the soft tissues. The direct result of this process is to minimise the effect of the infection on the cortex.

Thomson and Lewis (1950) described four cases occurring in premature infants. Two of the babies had no systemic upset at all. In the first case osteomyelitis of a phalanx followed paronychia; there was considerable loss of bone, with destruction of the distal interphalangeal joint. In the second case osteomyelitis of the ulna arose from an overlying pustule. The other two patients were acutely ill. One died with multiple staphylococcal bone lesions, apparently secondary to respiratory infection. The other had a staphylococcal paronychia of the toe, with secondary foci of infection in the ankle of the same leg, in one wrist, and in the left femur. The child recovered but the head of the right femur was destroyed and pathological dislocation occurred.

CASE REPORTS

Case 1—An infant of fourteen days was admitted with a twenty-four hours' history of generalised purpuric rash. The child had been well since birth. Examination showed a swelling over the upper end of the right tibia, and there was a leucocytosis of 33,000. There was umbilical sepsis.

FIG. 1

FIG. 2

FIG. 3

Case 1. Figure 1—Early radiograph showing displacement of the upper tibial epiphysis.
Figure 2—Later stage, showing much new bone formation and further tilting of the epiphysis.
Figure 3—Healed condition. Marked curvature of the tibia.

The general condition was remarkably good. Aspiration of the swelling yielded pus containing haemolytic streptococci. The purpura subsided in five days, but the swelling over the tibia persisted; a subperiosteal abscess was drained on the twelfth day of the illness. Radiographs showed, on the fifth day, signs of infection of the upper end of the tibia with elevation of the epiphysial plate (Fig. 1). Later radiographs showed that the periosteum had been elevated over a large part of the shaft, and a large, irregular involucrum was laid down; but there was no evidence of sequestration (Fig. 2). After drainage the infection rapidly subsided and healing was unhindered.

Late review—Radiographs two years later showed persistent distortion of the upper end of the tibia, and a further film four years later showed considerable secondary curvature of the upper

part of the tibial shaft (Fig. 3). The child has been seen recently at the age of eight years and there is no residual disability.

Case 2—A premature baby was born after thirty-one weeks' gestation. After delivery abrasions were noticed on the child's thorax. Two days later small papules were seen on the neck and axilla, and culture showed the presence of staphylococcus aureus, resistent to penicillin but sensitive to chloramphenicol, treatment with which was begun. When the child was a month old a deep abscess was found in the left thigh, with no overlying inflammation and no pyrexia. The general condition was good. Aspiration showed the causative organism to be staphylococcus aureus. Radiographs showed established osteomyelitis of the lower end of the femur, with subperiosteal new bone formation but no evidence of a sequestrum (Fig. 4). The abscess was drained and recovery was uneventful. Radiographs nine months later showed slight permanent residual bowing of the lower end of the femur (Fig. 5).

FIG. 4

FIG. 5

Case 2. Figure 4—Osteomyelitis of lower end of femur. Well marked involucrum but no sequestrum. Figure 5—Healed condition.

FIG. 6

Case 3. Osteomyelitis of radial shaft with massive involucrum.

Case 3—A child of six weeks was admitted with " paralysis " of her right arm. On the next day the right arm was swollen, hot and tender, and the temperature was elevated to 103 degrees Fahrenheit. The child was acutely ill. There was a leucocytosis of 24,000. Acute osteomyelitis was diagnosed and a course of penicillin was begun. The causative organism was not identified, and the primary source of the infection was not evident. Radiographs on admission showed no alteration from the normal. The pyrexia subsided within four days and there was a corresponding improvement in the general condition. Radiographs three weeks after admission showed massive involvement of the radial shaft, with considerable bone absorption and formation of involucrum but no evidence of sequestration (Fig. 6). Recovery was uneventful and radiographs four months later showed considerable remodelling of the radial shaft.

Case 4—A child of three weeks had had a normal birth and had previously seemed well. He then developed swellings of the right parotid and the right index finger, and appeared to use his right leg less than his left. Aspiration of the parotid swelling yielded staphylococcus aureus resistent to penicillin but sensitive to streptomycin. There was no constitutional upset apart from a rise of temperature to 99·2 degrees Fahrenheit on two occasions. A white blood count showed a total of 14,000 cells per cubic millimetre. Radiographs of the right hip and femur showed no abnormality. Four days later a large fluctuant abscess appeared over the right sacro-iliac region, but there was no overlying inflammation and no rise of temperature. The abscess was drained. Five days later a morbiliform rash appeared with generalised lymph-gland enlargement. The condition settled down quite rapidly and the child was discharged home. Nine days later he was readmitted with

spasm of the right hip. On examination there was marked limitation of movement but radiographs again failed to show any bony lesion. Repeat radiographs after a further two weeks, however, showed osteomyelitis of the right ilium with involvement of the sacro-iliac joint. The spasm of the hip gradually disappeared and no active treatment was instituted. The child was again discharged home. A month later he was readmitted with recurrence of flexion deformity of the right hip and a sinus over the right sacro-iliac joint. The hip was treated by skin traction and all spasm disappeared, the sinus healed and he was once more allowed free. But after a further six weeks an abscess appeared in the right groin. It was drained and the causative organism was identified as the staphylococcus aureus. The child was discharged home with this sinus unhealed. It continued to discharge for the next fifteen months and he then developed a large frontal abscess after a slight injury. This healed rapidly after drainage. Radiographs of the sacro-iliac joint at this time showed the possible presence of sequestra, and two small sequestra were removed at operation. The sinus healed but broke down again, and a year later a further sequestrum was discharged. Since then the lesion has remained healed, but radiographs showed obliteration of the right sacro-iliac joint.

Case 5—An infant girl was admitted to hospital twenty-three days after normal twin birth with pain and swelling in the right shoulder. There was pyrexia of 101 degrees Fahrenheit but the child was not acutely ill. Radiographs showed no abnormality. Osteomyelitis was diagnosed, but no primary source of the infection was evident. Two days later a large abscess was drained. The causative organism was the staphylococcus aureus. The wound continued to discharge. Further radiographs two months after the onset showed osteomyelitis affecting the proximal three-quarters of the shaft of the humerus, with pathological fracture and a massive sequestrum surrounded by a large involucrum (Fig. 7). It was feared that the shoulder joint was secondarily infected. There was also a Brodie's abscess in the metaphysis of the left tibia. The child's general condition remained good. At operation the sequestrum of the humerus was lifted out through the original sinus and the abscess of the tibia was drained. There was no periosteal spread of pus over the Brodie's abscess. Both wounds healed uneventfully. Radiographs five months after operation showed marked angulation of the humerus; but it was noted that the ossific centre for the humeral head had appeared (Fig. 8). Clinically the child uses the arm well and it seems likely that the shoulder joint will recover.

FIG. 7

FIG. 8

Case 5. Figure 7—Osteomyelitis of the humerus with large sequestrum. Figure 8—Healing condition. Sequestrum has been removed and the ossific centre for the head is now seen. The angulation followed a pathological fracture.

Case 6—A girl of eleven days was admitted with a history of normal birth and development until the eleventh day, when a lump appeared over the sternum. On the seventeenth day a swelling appeared over the lower end of the right tibia, and on the twenty-first day a large abscess formed over the left scapula. The child was remarkably well despite a pyrexia of 100·2 degrees Fahrenheit. Radiographs showed osteomyelitis of the lower end of the left tibia with a small sequestrum (Fig. 9), osteomyelitis of the left scapula (Fig. 10) and of the sternum. All three areas were drained; two small sequestra were extruded from the tibial abscess. The pus yielded staphylococcus aureus sensitive to penicillin; so treatment with this drug was begun. Two days later an abscess formed in the left thigh, and radiographs showed involvement of the lower end of the femur (Fig. 11). This abscess was drained and three weeks later the child was discharged with all the wounds healed. There has been no disturbance of growth.

COMMENT

Of these six cases of osteomyelitis of the long bones there were multiple foci of infection in three, and all the patients recovered. In only one case was there any serious constitutional upset. The other five fell into the group described by Greengard as "benign." In two of

these (Cases 4 and 5) there was evidence of joint infection, with complete destruction in the one but with probable recovery in the other. In Cases 1 and 2 there was residual deformity in consequence of epiphysial distortion, but serial radiographs show that much of this distortion was corrected as growth increased. Three patients formed sequestra, which is unusual in infantile osteomyelitis. In Case 5 the sequestrum measured four centimetres in length and comprised half the total length of the shaft. In all the cases rapid healing followed simple drainage, without any interference with the bone itself, except in the two cases in which sequestra had first to be removed. A striking feature was the formation of abundant

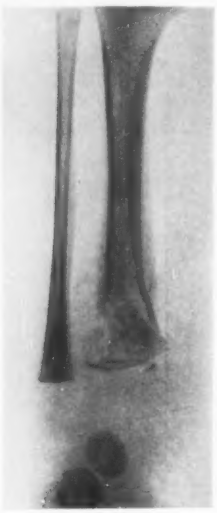

FIG. 9

FIG. 10

FIG. 11

Case 6. Figure 9—Tibia showing osteomyelitis with small cortical sequestrum. Figure 10—Left scapula. Figure 11—Left femur.

new bone beneath the periosteum. That this is so seldom associated with sequestration is possibly explained by the early decompression permitted by the spongy nature of the infant's bone and the loose attachment of the periosteum, as suggested by Green (1935).

SUMMARY

1. Recent published reports of neonatal osteomyelitis in long bones are reviewed.
2. Six further cases are described.
3. The source of infection is usually the skin or the umbilicus, and the common organisms are the haemolytic streptococcus and staphylococcus aureus.
4. Cases fall into two groups: in one the patient is acutely ill with septicaemia and the bone lesion is of secondary importance; in the other the general condition is well maintained even though there may be multiple bone lesions.
5. Sequestration is uncommon; but when it occurs it prevents the rapid healing that is usually observed after drainage.
6. The most important complication is suppurative arthritis, which may lead to total destruction of a joint.
7. It is probable that the lowered mortality from infantile septicaemia will be matched by a corresponding increase in the cases of acute osteomyelitis encountered in clinical practice.

I wish to thank Dr Everley Jones for giving me access to records of cases admitted under his care.

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THE USE OF CANCELLOUS BONE GRAFTS IN THE TREATMENT OF SUBACUTE AND CHRONIC OSTEOMYELITIS

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Compound fractures and gunshot wounds of bone are common injuries of war. Compound fractures are becoming common injuries of civilian life with the increasing number of traffic and industrial accidents. In spite of careful primary excision, the use of antibiotics and the early immobilisation of the affected limb, a bone infection may become established because of contamination of the wound, loss of skin and injury to adjacent soft tissues. With the present-day use of blood or plasma transfusions and the ability of antibiotics to localise the infection, the constitutional reaction of osteomyelitis is not great. The problem then confronting the surgeon consists of a low-grade infective process in bone associated with a bone defect, sequestra and sinuses.

If further treatment of the subacute osteomyelitis is not undertaken within a few months the condition of the lesion changes. Adjacent bone is further destroyed or becomes sclerotic, and an involucrum is slowly formed; muscles atrophy and scar, joints become stiff, and circulatory changes occur. The patient suffers economic loss and slowly develops an anxiety state. Such is the character of chronic osteomyelitis.

The tenacity of an established bone infection is well known and has often influenced the surgeon to advise amputation rather than undertake a prolonged and arduous reconstruction of the involved extremity. But attempts have been made throughout this century to develop a more acceptable method of treatment. The earliest were those of Carrel and Dakin, Orr (1927) and Baer (1931). With the advent of antibiotic agents new advances were made. Kelly *et al.* (1945), Knight and Wood (1945), Robertson and Barron (1946), Fischer (1946) and Reynolds and Zaepfel (1948) all reported satisfactory results with saucerisation followed in one to two weeks by a split-skin grafting. Shannon (1953) used saucerisation with immediate skin grafting and claimed good results. Buchman and Blair (1951) advocated initial closure by adjacent soft tissue after saucerisation; they stressed the use of antibiotics, especially aureomycin. Dickson *et al.* (1953) had equal success from a similar method with emphasis on local sulphathiazole and systemic penicillin.

The use of chip grafts of cancellous bone became popular after Mowlem (1944) reported success with the use of such grafts to restore skull contour, bridge mandibular defects and restore the continuity of long bones. Gordon (1946) also used chip grafts successfully for non-union of the mandible, despite the presence of infection in some cases. Ham (1950) found that, in experimentally transplanted cancellous bone grafts, most of the osteocytes died but that the covering osteogenic cells and osteoblasts might live if placed near capillaries and a good supply of tissue fluid.

Coleman *et al.* (1946) undertook saucerisation and cancellous bone grafting in a single stage for infected bone defects of the extremities. Later, Toumey and Shipp (1948), Hogeman (1949), Bickel and Bateman (1950) and Cleveland and Winant (1952) used cancellous chip bone grafts in the treatment of chronic osteomyelitis, and confirmed their remarkable viability and resistance to infection.

This paper is a review of the late results of the method employed by Coleman *et al.* (1946) in the treatment of Canadian Army veterans in Toronto, in which cancellous chip bone grafts were inserted at the time of saucerisation, or a few weeks afterwards, for subacute and chronic osteomyelitis.

CLINICAL MATERIAL

Between 1944 and 1948, 101 infected bone defects in Canadian Army veterans were treated at veterans' hospitals in Toronto by cancellous chip grafts. Since this method was new and untried, many of the patients selected were those with large and severe defects that were not considered amenable to established methods. The operations were performed by seven different orthopaedic surgeons working at the veterans' hospitals.

The cause of injury and the source of infection in these 101 cases are shown in Table I. Most were due to gunshot or shell wounds sustained in war actions in Italy and France. Four osteomyelitic defects from compound fractures of the first world war have been included. Six cases were of closed fractures treated by open reduction, with subsequent infection and sequestration. Two of these infections followed fractures of the clavicle treated by wire fixation, and four followed fractures of the tibia treated by open reduction with the application of metal plates or the insertion of screws. Five cases of haematogenous osteomyelitis, with bone abscesses in the tibia in four instances and in the humerus in one, are included.

The site of the bone defect was the tibia in sixty-three instances, the femur in twenty-two, the humerus in eight, the clavicle in two, and a bone of the foot in six. No estimate of the size of the bone defects was made for this paper.

TABLE I

ETIOLOGY OF 101 INFECTED BONE DEFECTS

Compound fractures		90
1914–18 war	4	
1939–45 war	86	
Simple fractures infected after open reduction		6
Haematogenous osteomyelitis with abscess		5

Cultures of the infected area were recorded in seventy-eight cases, and a growth of organisms reported in all but four. Mixed infections were present in thirty-eight instances. Staphylococcus aureus haemolyticus was the most common organism, with bacillus pyocyaneus and bacillus proteus next in frequency.

METHOD OF TREATMENT AND SURGICAL TECHNIQUE

On admission the patients had radiographs taken out of plaster, often with a probe or radio-opaque fluid inserted into the bone defect. A culture of the discharge from the wounds was usually taken before operation. Penicillin was administered routinely in doses of 20,000 units every three hours for two days before operation and for seven to ten days afterwards.

The operation was performed when possible with the use of a pneumatic tourniquet. In many cases methylene blue was injected into the sinuses to outline the infected bone cavity. The sinus and all infected material, including sequestra, granulation tissue and sclerotic bone, were excised. Meanwhile an assistant removed shavings or chips of cancellous bone from the iliac crest; both crests were used if the bone defect was large. The pieces of cancellous bone were carefully trimmed of all cortical fragments, mixed with penicillin and sulphathiazole powder and loosely packed into the bone cavity. The soft tissue and skin were closed without tension. A carefully padded dressing and a plaster were applied for at least three weeks, or as long as necessary to allow union of an associated fracture.

Single-stage sequestrectomy with cancellous chip bone-grafting was performed in seventy-six of the 101 cases. In the other twenty-five cases sequestrectomy and packing of the wound were performed one to eight weeks before the bone-grafting operation. In fourteen instances a tube pedicle graft or other type of full thickness skin graft was prepared before the bone-

grafting operation. In an additional eight cases a local skin shift or rotation flap was done at the time of bone grafting. Ancillary procedures included exploration of the sciatic nerve in two cases, exploration and suture of the posterior tibial nerve in one case, fusion of the knee in two cases and fusion of the ankle in two cases.

RESULTS

Almost all of the 101 patients who have had a cancellous bone graft for osteomyelitis are on a government pension and are recalled for regular pension examinations. Although they live at widely scattered places throughout Canada and the United States, it is likely that all " flare-ups " of infection are reported to the Department of Veterans' Affairs for payment of the local hospital and surgeon. Thus a complete follow-up of all cases has been possible. As a further check on available records a letter was sent to all patients requesting information about the site of the bone graft. Ninety-eight letters were mailed and ninety-three letters returned with the requested information.

The early results obtained from the hospital records are given in Table II. At the first change of plaster seventy-five of the 101 wounds were found to be completely healed. An additional twenty-three wounds healed by delayed primary or by secondary intention. In twelve of this latter group primary healing failed because of necrosis of the skin edges or a stitch abscess. However, the wounds healed by delayed primary intention within a few months without further operation. The other eleven wounds which healed by secondary intention required additional operations to secure satisfactory closure. The patients with this complication required prolonged immobilisation of the affected extremity and often remained in hospital for one to two years. The additional operative procedures required to obtain healing are shown in Table II. The cause of failure of the primary operation was usually inadequate skin coverage or inadequate removal of infected bone lining the cavity.

TABLE II
EARLY RESULTS

Primary healing		75
Delayed primary healing		12
Secondary healing with further operation		11
Excision of sinus	1	
Sequestrectomy	5	
Repeated bone grafts	2	
Tube pedicle skin graft	1	
Muscle graft	2	
No healing obtained		3

The two cases of partial revision of the original bone graft with the use of a pedicle muscle graft should be considered failures of the bone-graft method. In addition, three other cases should be classed as failures because of failure to obtain either primary or secondary healing. One developed a recurrence of a draining sinus after attempted obliteration of a bone cavity in the tibia. This cavity had followed a gunshot wound received in 1915. No further operation was attempted in this case because the patient was elderly and had already gained moderate benefit from reduction in the size of the sinus and the amount of discharge. In the other two cases infected defects of tibia persisted in spite of repeated unsuccessful operations. A Gritti-Stokes and a below-knee amputation were performed six and seven years after injury.

A study of the later results (five to nine years) has revealed a recurrence of osteomyelitis in twenty-one of the healed cases. Most have been single recurrences requiring drainage of

an abscess or a sequestrectomy (Table III). More troublesome recurrences have occurred in five cases, with repeated attacks of osteomyelitis at intervals of a year or so over the past five to nine years. It is these cases that should be considered failures of the method of treatment because the recurrent infections have interfered seriously with the social and economic life of the patients. Thirteen of these twenty-one patients suffering either single or multiple recurrences have undergone further operation (Table III). The surgical procedure has usually been minor, but in one patient a repeat cancellous bone graft was done successfully seven years after the initial operation.

TABLE III

RECURRENCES (FIVE TO NINE YEAR FOLLOW-UP)

Single recurrence of infection	16
Repeated recurrence of infection	5
Requiring further operation	13
Drainage of abscess	8
Excision of sinus	2
Sequestrectomy	8
Repeat bone graft	1

TABLE IV

LATE RESULTS (FIVE TO NINE YEAR FOLLOW-UP)

Satisfactory	91
Failures	10
Repeated recurrences of infection	5
Revision with muscle graft	2
Still draining	1
Amputation	2

The final assessment after five to nine years' observation is given in Table IV. The criteria that determine a failure of the method are controversial. Lesions that heal by secondary intention after further surgery, and lesions giving single recurrences that were readily treated, are not considered to be failures because almost the entire graft is alive and functioning. But ten of the 101 cases must be regarded as total failures. Five patients are suffering from approximately yearly recurrences of infection characterised by pain, swelling and redness at the site of operation; in two patients the cancellous bone graft had to be replaced by a pedicle muscle graft; in one a sinus is still draining; and in two others amputation was performed.

In the remaining ninety-one cases healing was obtained and the infection is inactive. The original bone defects are obliterated and radiographs show the cancellous bone grafts well incorporated in the host bone. Representative illustrations are given in Figures 1-10.

DISCUSSION AND CONCLUSIONS

The early results of this method of treatment of infected bone defects appeared very promising with eighty-seven of the 101 defects filled with apparently living bone and covered by intact skin. An additional eleven cases obtained at least partial obliteration of the infected defects but required a further operation for complete obliteration and healing. These early results showed only three complete failures. But as the years have gone by recurrence of osteomyelitis in apparently quiescent foci has been observed in twenty-one of the ninety-eight healed lesions. Fifteen of these recurrences have been easily handled, but five patients continue to have almost yearly flare-ups.

In an attempt to find the causes of these recurrences various factors have been assessed. It can be concluded that osteomyelitic defects of twenty-five to thirty-five years' duration are difficult to treat successfully. This is probably explained by the more extensive sclerosis of bone, scarring of muscle and the greater age of the patients. It was also found that the single-stage operations were more often successful than those done in multiple stages. Perhaps the more extensive bone and soft-tissue defects were treated in multiple stages and could be expected to give poorer results, but it is also possible that open packing of the bone cavity at the first operation deprived the adjacent bone and soft tissues of blood supply and allowed secondary invading organisms to flourish in the wounds. Such avascularity and contamination would certainly interfere with the subsequent bone graft.

Statistical analysis has shown that bacillus proteus and bacillus pyocyaneus are important causes of failure of the surgical procedure. These bacteria are not controlled by penicillin and sulphathiazole, which were the only two drugs used extensively in the cases in this series. It appears essential that the bacterial flora of an osteomyelitic lesion be controlled by antibiotics before a cancellous bone graft can be done with the assurance of a satisfactory result. This fact is of even greater import at the present time because of the increasing incidence of staphylococci that are resistant to the sulpha drugs, penicillin, and the newer wide-spectrum antibiotics. To allow the surgeon to continue his attempts to clear up foci of osteomyelitis the development of new antibiotics effective against staphylococci and the application of locally effective drugs such as bacitracin and polymixin are important.

FIG. 1 FIG. 2 FIG. 3 FIG. 4

Case 1—Man aged twenty-two. Compound fracture of left femur from shell wound. Figure 1—Initial radiograph. Figure 2—Six months later. A sinus persisted despite sequestrectomy. Figure 3—Four months after filling the cavity with cancellous bone grafts. Wound healed. Figure 4—Eight years later. No recurrence of infection.

It has been stressed by several authors (Coleman *et al.* 1946, Buchman and Blair 1951) that the sequestrectomy and saucerisation before closure of an osteomyelitic lesion must be thorough. Evidence can be found in this series that the most experienced surgeon had fewer complications and recurrences in the cases under his guidance and control.

From the observations made in the five to nine year follow-up, I would like to suggest that each lesion of subacute or chronic osteomyelitis should be considered from the point of view of the site of the defect, the availability of soft tissue and skin coverage, and the sensitivity of the infecting organisms to antibiotics, and that the treatment be dependent upon these factors. Depending on the characteristics of the lesion there are available several methods of treatment. In spite of the troublesome complications and recurrences after the use of cancellous chip bone grafts, comparison with other methods shows no significant difference in the probability of eventual success, whether it be primary closure with adjacent soft tissue, primary and secondary closure with split thickness skin graft, or primary muscle graft (Prigge 1946).

The indications for a cancellous chip bone graft include osteomyelitic lesions that have

caused a deep or large bone defect in an area of the body where sacrifice of considerable bone would be necessary to allow soft tissue closure. The criteria to be fulfilled for a successful cancellous chip bone graft in osteomyelitis are: 1) Control of the infecting bacteria by

FIG. 5 FIG. 6 FIG. 7

Case 2—Man aged forty-four, with gunshot wound of left tibia. Figure 5—Initial radiograph. Figure 6—After sequestrectomy. Figure 7—Eight years after cancellous chip bone grafting.

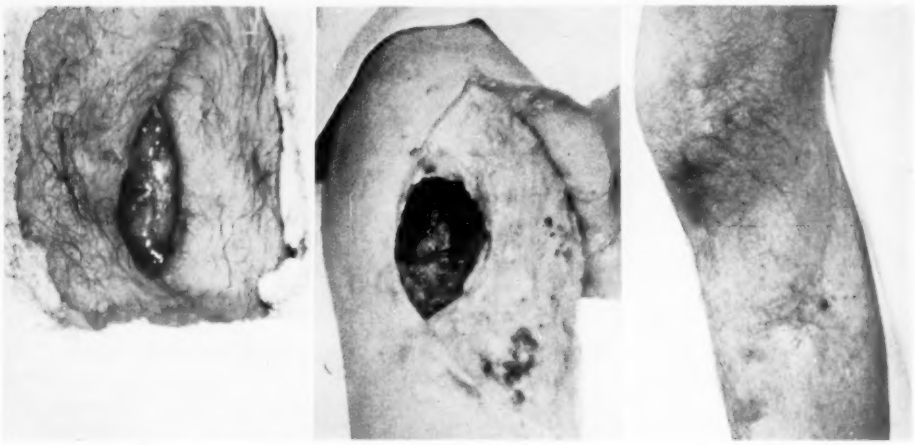

FIG. 8 FIG. 9 FIG. 10

Case 2. Figure 8—Persistent sinus before operation. Figure 9—The bone defect after sequestrectomy; a skin flap has been mobilised. Figure 10—Wound healed after cancellous chip grafting.

antibiotics applied systemically or locally; 2) full thickness skin coverage of the wound; 3) complete removal of all infected bone and soft tissue; 4) sufficient saucerisation of bone and excision of soft tissue scar to expose a vascular bed for the bone grafts; 5) decortication of the chip grafts; 6) obliteration of all dead space by the loose packing of sufficient small bone

chips; 7) immobilisation of the affected area to allow soft tissue healing or bony union of an associated fracture.

When these criteria are satisfied cancellous chip bone grafting for subacute or chronic osteomyelitis is a sound procedure, with a definite place in treatment.

SUMMARY

1. One hundred and one cases of cancellous chip bone grafting operations for filling of infected bone defects are reviewed.
2. Short-term follow-up showed primary or delayed primary healing in 87 per cent of the cases.
3. Observation after five years revealed a recurrence rate of 20 per cent. The recurrences were successfully overcome by minor procedures except in five patients, who suffer from repeated flare-ups of infection.
4. At the present time, 91 per cent of the lesions are satisfactorily healed with a partial or complete bone graft intact. There have been ten failures.
5. The criteria for successful cancellous chip bone grafting of osteomyelitic cavities are discussed.

The author would like to acknowledge with appreciation the encouragement of the orthopaedic staff of Sunnybrook Hospital in the preparation of this paper.

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LOCALISED OSTEOCHONDRITIS OF THE LUMBAR SPINE

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Osteochondritis affecting the thoracic spine (Scheuermann's disease) presents a characteristic and widely recognised clinical and radiographic picture. It usually produces symptoms between the ages of twelve and seventeen, and radiographs show a minimal anterior wedging of the bodies of adjacent vertebrae in the middle and lower regions of the thoracic spine. Considerable attention had been paid to this common condition, but there is little reference in the literature to an affection, which appears to be of the same nature, involving a small localised area of the lumbar spine and producing a characteristic defect of the vertebral

FIG. 1

FIG. 2

Case 1. Figure 1—Initial radiograph. Figure 2—Fourteen months later.

body. Hafner (1952) drew attention to localised Scheuermann's disease affecting the lower thoracic spine in four patients aged between fourteen and seventeen, but said that localised bone destruction never occurred.

The purpose of this paper is to report cases in which a similar localised condition was found in the lumbar spine and to emphasise the importance of differentiation from tuberculosis, which it may resemble closely.

CASE REPORTS

Case 1—A girl aged fourteen was admitted to hospital complaining of pain in the lumbar spine. There was spasm of the lumbar paravertebral muscles with limitation of movement. Radiographs showed narrowing of the disc space between the first and second lumbar vertebrae, and a defect suggestive of necrosis at the upper anterior angle of the second vertebral body (Fig. 1). The

radiographic appearance, together with the local signs, strongly suggested a tuberculous infection. The erythrocyte sedimentation rate was 5 millimetres in the first hour; differential leucocyte count was normal; a chest radiograph showed no alteration from the normal. The Mantoux test 1/1000 was negative. There were no symptoms in the thoracic spine, but radiographs showed evidence of early epiphysitis of the lower thoracic vertebrae. In view of this and the negative tests for tuberculosis, the diagnosis of localised lumbar epiphysitis was made. She was treated by strict rest in bed for six weeks, and thereafter by postural exercises and a Taylor brace. In the past year there has been no return of symptoms. Radiographs fourteen months after the onset showed normal appearances in the bones, but there was persistent narrowing of the disc space and apparent calcification in the intervertebral disc (Fig. 2).

Case 2—A girl aged ten attended with faulty posture, and complained of pain in the lumbar spine. Radiographs showed narrowing of the disc space between the second and third lumbar vertebrae with a bony defect at the upper anterior angle of the third lumbar vertebra (Fig. 3). The erythrocyte sedimentation rate, differential leucocyte count and chest radiograph were normal.

FIG. 3

FIG. 4

FIG. 5

Case 2. Figure 3—Initial radiograph. Figure 4—Six months later. Figure 5—Eighteen months after onset.

The Mantoux test 1/1000 was negative. Progress was observed for six months, during which postural exercises were encouraged. There was no deterioration clinically, but radiographs showed further narrowing of the disc space and extension of the defect with sclerosis of the surrounding bone (Fig. 4). A year later, however, healing had occurred and the narrowing of disc space was less marked (Fig. 5).

Case 3—A boy aged fifteen attended with pain in the left hip region for three weeks. On examination his posture was poor, but movements of the lumbar spine were normal. There was no complaint of pain in the back. Hip movements were normal. Radiographs showed irregularity of the upper border of the fourth lumbar vertebral body with a defect at the upper anterior corner (Fig. 6). The erythrocyte sedimentation rate, differential leucocyte counts and chest radiograph were normal. The spine was immobilised in a plaster shell for three months. Intermediate radiographs six weeks after the first showed a similar lesion of the anterior upper corner of the fifth lumbar vertebra with slight narrowing of the disc spaces and a central nuclear protrusion (Fig. 7). After three months there was reconstitution of the normal shape of the vertebral bodies (Fig. 8). The patient has remained free from symptoms.

Case 4—A boy aged fifteen was admitted to hospital complaining of low back pain. Radiographs showed a defect at the lower anterior corner of the second lumbar vertebral body with slight

FIG. 6

FIG. 7

FIG. 8

Case 3. Figure 6—Initial radiograph. Figure 7—Six weeks later. Figure 8—Three months after onset.

FIG. 9

FIG. 10

Case 4. Figure 9—Initial radiograph. Figure 10—Six months later.

narrowing of adjacent disc space (Fig. 9). There were mild changes of vertebral epiphysitis in the thoracic region. He was treated by rest in bed for six months. Subsequent radiographs showed consolidation of the vertebral defect (Fig. 10). When he was last seen a year and a half after the onset he was free from symptoms.

Case 5—A boy aged fourteen, brother of the previous patient, was admitted to hospital with low back pain. Radiographs showed a defect of the upper anterior angle of the fourth lumbar vertebra (Fig. 11). The erythrocyte sedimentation rate and differential leucocyte count were normal, and a radiograph of the chest showed no abnormality. He was treated by rest in bed for three months. Radiographs a year later showed complete recovery (Fig. 12). When he was last seen nearly two years after the onset he was free from symptoms.

FIG. 11

FIG. 12

Case 5. Figure 11—Initial radiograph. Figure 12—A year later.

Case 6—A girl aged fourteen was admitted to hospital with a complaint of low back pain. She gave a history of a fall on to the buttocks at gynmastics six months previously: pain had increased progressively thereafter. Radiographs showed erosion of the upper anterior angle of the second lumbar vertebral body with narrowing of the disc space above it (Fig. 13). The lesion was considered to be post-traumatic, and she was treated by one week's strict rest in bed followed by a plaster jacket for three months. Later radiographs showed that the changes had become more pronounced. The true nature of this lesion was shown by subsequent radiographs a year after the first: these showed a similar but smaller defect at the upper anterior angle of the third lumbar vertebral body (Fig. 14.) Three months later there was almost complete regeneration (Fig. 15).

Case 7—A girl aged thirteen attended with low back pain. She had a poor posture with a mobile thoraco-lumbar scoliosis, but no other abnormality was shown radiographically. Treatment was by postural and spinal exercises. When seen again six months later she still complained of pain. Radiographs showed an area of bone destruction at the upper anterior angle of the body of the third lumbar vertebra (Fig. 16). The erythrocyte sedimentation rate and differential white blood count were normal, and, as there was also radiographic evidence of mild mid-thoracic epiphysitis, she was treated for localised lumbar osteochondritis of a non-infective nature. Fifteen months later she still had some back pain, and radiographs showed the defect well defined (Fig. 17). She continued to have aching pain for some months, but eventually, three years after her initial complaint, she became free from symptoms and had a good posture with a full range of spinal movements. Recent radiographs four years after the onset show the defect still present but in the healing phase (Fig. 18).

FIG. 13

FIG. 14

FIG. 15

Case 6. Figure 13—Initial radiograph. Figure 14—A year later. Figure 15—Three months later still.

FIG. 16

FIG. 17

FIG. 18

Case 7. Figure 16—Initial radiograph. Figure 17—Fifteen months later. Figure 18—Four years after onset.

DISCUSSION

These seven cases of localised lesions of the lumbar spine in children are considered to be examples of vertebral osteochondritis. All the patients complained of pain, six in the lumbar spine, the other in the region of the hip; in three there was considerable paravertebral muscle spasm with restriction of movement. The radiographic appearance was alike in each case: there was narrowing of a disc space with a characteristic defect of the upper or lower anterior corners of the adjacent vertebral bodies. In some, a central disc protrusion was present.

It seems likely that this condition is caused primarily by weakness of the intervertebral disc—either congenital or post-traumatic. The constant narrowing of the disc space and the occasional appearance of Schmorl's nodes are certainly suggestive of this hypothesis, which also offers a possible explanation of the characteristic defect at the upper or lower anterior corners of the vertebral bodies bounding the disc space. As the fluid nuclear material escapes from the disc, with resultant narrowing of the space, it may break the cartilage plate to form Schmorl's nodes, but may equally allow pressure anteriorly. The tough anterior longitudinal ligament resists this force, which is directed on to the upper or lower corner of the vertebral body with consequent pressure necrosis of bone and formation of the radiographic defect described.

It is important to distinguish this condition from spinal tuberculosis. All the lesions reported had been diagnosed by competent radiologists as probably being tuberculous. The following are important points in differentiation: 1) The erythrocyte sedimentation rate, differential leucocyte count and chest radiograph are normal. 2) The Mantoux test is often negative. 3) Schmorl's nodes or other radiographic evidence of vertebral epiphysitis are present (although asymptomatic) in the thoracic spine. 4) The defect of the vertebral body has a rather typical " punched-out " appearance. 5) There is never any suggestion of abscess formation.

Treatment—It has been noted in these cases that there has been a slow regeneration of the vertebral defect over a period of months. This return towards normality was achieved in three cases despite weight bearing and normal activity. In the remainder bed rest, with or without a plaster shell, for two to six months, was considered necessary.

It is suggested that the treatment required depends on the symptoms and signs. If they are mild, supervision in the out-patient clinic, with restricted activity, is adequate. If there are considerable pain and muscle spasm, complete rest on a firm bed should be ordered until the symptoms subside; thereafter a plaster jacket or spinal support should be worn for two to three months.

SUMMARY

1. Seven cases of localised lumbar spine defects in children associated with low back pain are described.

2. The importance is emphasised of the recognition and differentiation of the condition from tuberculosis, which it may resemble both clinically and radiographically.

I should like to thank Professor Walter Mercer and Mr R. I. Stirling for their help and constructive criticism with these cases.

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COMPLETE PROTRUSION OF A CALCIFIED NUCLEUS PULPOSUS IN THE THORACIC SPINE

Report of a Case

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The clinical and radiological diagnosis of rupture of the intervertebral disc and backward prolapse of the nucleus pulposus is commonplace in the lumbar region and is sometimes made in the cervical region also. Calcification of the nucleus pulposus is occasionally observed radiologically in the thoracic spine, but rarely in other vertebral regions. Prolapse of the nucleus is distinctly uncommon in the thoracic spine.

This case report is concerned with the demonstrable prolapse of a completely calcified nucleus in the lower thoracic spine—a rare occurrence. It is surprising that such a happening has not been observed and recognised more frequently.

Clinical and radiological features—The patient was a married woman, aged forty-seven years. In September 1953 she first complained of a severe "stitch-like" pain in the region of the left lower costal margin and lower sternum. She described this pain as tingling and continuous, worsened by most movements, especially by flexion of the trunk. The pain was slightly relieved by aspirin-codeine tablets. Later, the pain tended to spread to the right lower costal margin, though it was never so severe there as on the left side. Her sleep was appreciably disturbed by the pain.

She first attended as an out-patient at St Mary's Hospital a month after the onset. *On examination*, there was no spinal deformity but there was some rigidity of the back with spasm of the sacro-spinalis muscles. The normal thoracic curve was preserved. There were no demonstrable abnormal motor or sensory neurological signs in association with this girdle pain.

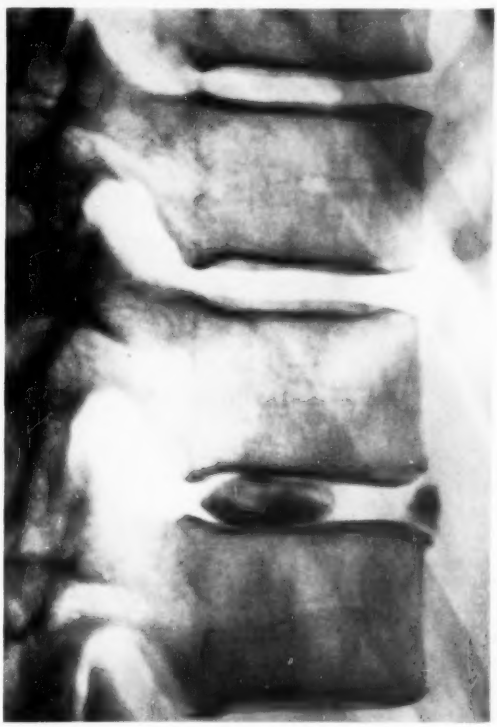

FIG. 1

Initial radiograph showing total calcification of nucleus pulposus between T.10–11, and calcification at the anterior margin of the annulus fibrosus.

Radiological examination was carried out on the first day of her attendance. In the mid-thoracic spine there was slight anterior marginal osteophytic lipping affecting the bodies of the fifth to the eighth thoracic vertebrae. In the lower thoracic spine, between the bodies of the tenth and eleventh thoracic vertebrae,

a striking example of calcification of the nucleus pulposus was evident (Fig. 1). The uncorrected dimensions of the calcified nucleus were: antero-posterior, 21 millimetres; supero-inferior, 7 millimetres; transverse, 24 millimetres. Anteriorly, at the same level, there was some separate dense calcification, probably in the anterior margin of the annulus fibrosus. There was slight osteophytic lipping at the lower margin of the tenth and at the upper margin of the eleventh thoracic vertebrae. From before backwards, the measurements of the disc space were 5, 7, 8 and 5 millimetres.

The patient was admitted to hospital under the care of Mr Dickson Wright ten weeks after the onset. She was then in considerable pain. She was most comfortable when lying supine with a pillow supporting the lumbar curve. The physical examination showed no

FIG. 2

FIG. 3

Figure 2—Lateral tomograph two months later. Figure 3—Lateral radiograph on the following day. These show: 1) narrowing of the disc space between T.10–11; 2) complete postero-inferior escape of the calcified nucleus pulposus which lies behind the body of T.11; 3) slight forward displacement of the anterior marginal calcification of annulus fibrosus.

significant change from that already described. A week after her admission the severity of the pain was unaltered, but two days later the patient was much better and after a further week she was able to walk about the ward without much discomfort.

Further radiological investigations—Five days after the pain had begun to subside a tomographic examination was made with somewhat surprising findings (Fig. 2). Because of a misunderstanding, a " simple " spinal radiographic examination was not made immediately before tomography, but this oversight was remedied on the next day (Fig. 3). The following description applies to both these examinations. In comparison with the findings at the first examination two months before: 1) The whole of the calcified nucleus pulposus had been extruded posteriorly and was seen to lie behind the upper part of the body of the eleventh

thoracic vertebra and was probably intact (Figs. 2 and 3). 2) The intervertebral disc space had become appreciably narrowed and its dimensions were 4, 4, 5 and 4 millimetres from before backwards. The slightest remnants of calcification in the annulus near the normal site of the nucleus were just detectable. The anterior marginal calcification showed a slight forward protrusion. 3) The postero-superior margin of the body of the eleventh thoracic vertebra was defective, as if marginal avulsion had occurred when the complete disc rupture and nuclear total protrusion occurred (Fig. 4).

Progress—The patient's condition had improved so markedly that Mr Dickson Wright decided that surgical intervention was not indicated and she was discharged.

FIG. 4

Antero-posterior radiograph taken on the same day as Figure 3, showing a defect in the supero-posterior margin of the body of T.11, seen immediately below the spinous process of T.10. The prolapsed nucleus is just visible superimposed on the spinous process of T.11.

The patient was seen again six months after the onset of symptoms and she no longer complained of lower thoracic pain. Further radiographs were taken which confirmed the marginal defect in the body of the eleventh thoracic vertebra, but this had not increased. The calcified nucleus remained in the same position.

DISCUSSION

The radiological appearances seen at the second examination (Figs. 2 to 4) would have been extremely difficult to interpret had the previous findings not been known. It is quite possible that a mixed osteolytic and osteosclerotic infective or neoplastic lesion affecting the

postero-superior part of the body of the eleventh thoracic vertebra would have been erroneously suspected.

It is interesting to consider at what time the complete nuclear prolapse occurred. Marked pain was present when the patient was first examined and it began to improve soon after her admission six weeks later, but the change towards improvement was not abrupt. Further, the pain had not had an abrupt onset initially nor was there any definite strain or injury of which the patient was conscious at any time. There is no means of telling whether the total nuclear prolapse occurred before or after the patient was confined to bed, but it must have taken place in the two months' interval between the first and second radiological examinations. It seems possible that the extrusion was a gradual process and was complete at the time of the second examination when definite amelioration was reported.

It is interesting to note that, whereas nuclear calcification is most often seen in the lower thoracic spine, proven intraspinal rupture of the disc is rare at this level; further, calcification is seldom found at the commonest sites of prolapse. In the present case we have a visible demonstration of a complete rupture and the prolapse of a calcified nucleus associated with relief of symptoms.

Calcification within the spinal canal is a rare finding. It has been described in meningioma by Duff Gray (1942). It could well be seen if, in spinal caries, a cold abscess with calcareous debris tracked into the spinal canal. This case report shows that a calcified nucleus which had prolapsed could also show intraspinal calcification.

The opinion is expressed in Schinz's *Roentgen Diagnostics* (1952) that calcification of the nucleus pulposus carries little or no clinical significance. However, in a recent paper, Logue (1952) wrote: " It would seem that nuclear calcification in the thoracic region is indicative of a degenerative change of such a nature as to render the disc liable to prolapse, but this change may also be present in other discs as yet uncalcified, and it may happen that prolapse occurs from one of the latter. In a person suffering from spinal cord compression in the thoracic region calcification of the nucleus pulposus is an important finding, and as a general guide it may be stated that if the segmental level of the lesion corresponds with a calcified nucleus then the diagnosis of a protruded disc is practically certain, and even when the segmental level does not correspond a herniation is still the most likely diagnosis."

In the case described here, there was radiological evidence of escape of the whole nucleus posteriorly: judging from the history, there was pressure on the nerve root which was possibly relieved when the total rupture occurred. A close inspection of the lateral radiographs and tomographs suggests that pressure on the cord would have been almost inevitable if it were not for the " avulsion " or " giving way " of the postero-superior margin of the body of the eleventh thoracic vertebra, so that the nucleus (which is probably almost intact) does not bulge markedly into the spinal canal behind the plane of the posterior margin of the body.

My thanks are due to Mr Dickson Wright for permission to report this case under his care.

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CALCIFICATION OF INTERVERTEBRAL DISCS IN CHILDREN

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Calcification of intervertebral discs was first described by Calvé and Galland (1922). Since then many other cases have been recorded, the calcification usually occurring in the nucleus pulposus but occasionally in the peripheral part of the intervertebral disc. The condition may cause vague symptoms, but in most cases it is an accidental finding on radiographic examination, apparently causing no symptoms at all. Usually the calcification is seen in the thoracic or thoraco-lumbar region.

Most cases have occurred in adults and calcification in intervertebral discs of children has seldom been found; only seven cases have been fully recorded in the literature. Unlike calcification in adults, the condition can be accompanied by quite marked signs and symptoms, and it is therefore of more clinical significance.

Báron (1924) described the case of a boy aged twelve who complained at first of influenzal symptoms, backache and a temperature of 101·3 degrees Fahrenheit. By the tenth day the pain was more severe and he had some kyphosis. He had an erythrocyte sedimentation rate of 32 millimetres in the first hour and a leucocytosis of 12,000 cells per cubic millimetre. Radiographs showed a large calcified area in the disc between T.12 and L.1 with a smaller area between L.1 and L.2. The pain and temperature subsided in a few days and recovery was complete in four weeks. Subsequent radiographs showed the calcified areas slightly larger four months later, but after one year they had disappeared.

Kohlmann (1931) described a twelve-year-old boy who complained of sudden backache with slight tenderness in the upper thoracic region. Radiographic examination showed a dense calcified area in the disc between T.4 and T.5. The symptoms persisted for a few weeks only and after two months the calcified zone was very much smaller.

Lyon (1932) gave a description of a boy aged eight who had sudden pain and stiffness of the neck. He had a high fever for two days, but recovery was complete after twelve days. Dense calcification between T.6 and T.7 was seen on radiographic examination. This was much less five months later and had disappeared in eight months.

Von Held (1934) gave an account of a ten-year-old boy who had pain in the head, neck and left shoulder. He had stiffness of the neck with some hyperextension. Radiographs showed dense calcification in three discs, between C.2 and C.3, C.3 and C.4, and C.5 and C.6. The pain had cleared up at the end of two months and the calcification had disappeared after two and a half months.

Keyzer (1939) published the case of a boy of two and a half who had sudden severe pain in the neck accompanied by a raised temperature and marked stiffness. The child had a leucocytosis with a white cell count of 14,000 cells per cubic millimetre. Radiographs showed calcification in the anterior halves of the discs between C.2 and C.3, C.3 and C.4, and C.4 and C.5. The symptoms slowly subsided over the course of several weeks, but no change was seen on radiographic examination several months later.

Weens (1945) was the first to publish a case in a female child. A five-year-old girl had marked pains in the back of the head and neck for five days and a temperature of 100 degrees Fahrenheit. She had had some aching for two months before this. She had hyperextension of the neck with very limited flexion and marked thoracic kyphosis. Radiographs showed dense calcification between C.6 and C.7. The white cell count was only 8,200 per cubic

millimetre, but after eight days it had risen to 11,400. The temperature returned to normal after two days and the pain had gone in four days. A radiograph twelve days afterwards showed the calcified area smaller, and it had disappeared in four months.

Cohen, Burnip and Wagner (1949) gave an account of a girl aged six who had complained of recurrent abdominal pain for three years. There were no abnormal physical signs but a radiograph showed calcification in the disc between T.12 and L.1. It was thought that the pain could not be attributed to the calcified disc.

CASE REPORT

In June 1944 a girl aged ten was referred to the Stafford General Infirmary on account of pain behind the left hip for ten weeks. Her mother stated that the child had never held herself well and that she had complained of occasional pain when her back was jarred.

There was no abnormality to be found in the left hip, but the child had marked lumbar lordosis and some thoracic kyphosis. She had some limitation of movement of the upper lumbar spine with tenderness to the left of the upper lumbar region. The blood count was normal.

Radiographs showed dense areas of calcification in three discs, the lowest thoracic and the upper two lumbar (Fig. 1). The uppermost mass corresponded fairly accurately with the position of a normal nucleus pulposus but with slight bulging into the body on either side. The lowest calcified area was larger and was not only bulging into the posterior thirds of both adjacent bodies but was also projecting backwards into the intervertebral canal. The middle calcified mass appeared to be disintegrating, and a large part of it had escaped laterally to the left side of the disc. The other lumbar discs showed slight bulging of the nucleus pulposus into the bodies, but no calcification.

The patient was advised to rest in bed at home, but a radiograph two weeks later showed the lowest disc to be projecting further into the canal, and more of the central calcified mass had " oozed " out laterally (Fig. 2). It was therefore decided to immobilise the spine, and the child was supported on a straight frame. After three or four months, the calcification between T.12 and L.1 had almost disappeared, but there was no obvious change in the other two discs (Fig. 3).

The patient had no further symptoms, but the lowest calcified disc still appeared to be projecting into the canal, and frame fixation was continued for six months. She was then allowed up with a back support and periodic check radiographs were taken. There was no change until the end of 1946—two and a half years after the onset—when the upper calcified mass slowly absorbed but did not completely disappear (Fig. 4).

The patient remained symptom-free until August 1947, when she had some pain in the right loin for a few days. A radiograph then showed the lowest calcified mass becoming fragmented (Fig. 5), and four months later it had almost disappeared (Fig. 6). Three years later, in 1950, the only calcification persisting was a slight amount in the disc between T.11 and T.12; this had completely disappeared by 1952.

The patient has had no further symptoms, and clinically, apart from moderate lumbar lordosis, she appears to have a normal spine. A recent radiograph (Fig. 7) shows very slight narrowing of the three affected discs. Apart from slight persistence of the bulging into the posterior thirds of the bodies adjacent to the affected discs, the vertebrae are of normal contour.

DISCUSSION

This case did not present the marked clinical symptoms of some of those previously recorded, but a serious complication might have arisen if the calcified nucleus pulposus had prolapsed farther backwards into the canal. This threat was averted by prolonged immobilisation in recumbency followed by the wearing of a posterior spinal support.

FIG. 1

Dense areas of calcification in intervertebral discs between T.11–T.12, T.12–L.1 and L.1–L.2. The calcified mass between T.12 and L.1 disintegrating and escaping laterally; that between L.1 and L.2 projecting backwards in the canal.

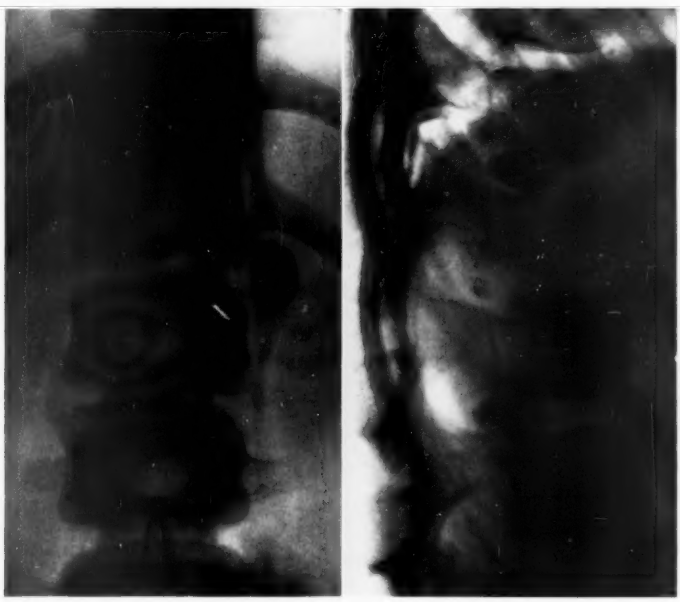

FIG. 2

Two weeks later. More of the calcified mass has oozed out laterally and the lowest disc has protruded slightly further backwards.

FIG. 3

FIG. 4

Figure 3—After four months, the calcification between T.12 and L.1 has disappeared.
Figure 4—Two years later. The T.11–T.12 disc is almost clear of calcification.

FIG. 5

FIG. 6

FIG. 7

Figure 5—Three years after onset. Pain in left loin for a few days. Remaining calcified mass disintegrating.
Figure 6—Four months later. Calcification almost disappeared. Figure 7—June 1954; ten years after onset. No calcification but slight narrowing of the three affected discs. Bodies of normal contour except that the discs still bulge into their posterior thirds.

It is notable that, in the author's case at least, the calcified masses caused no symptoms while they were lying dormant. The only two occasions on which the patient complained of pain corresponded with the disintegration of the calcified zone before its absorption.

The cause of calcification in intervertebral discs in childhood is uncertain. In adults, the calcification is probably part of the process of degeneration occurring in discs and, as such, is probably irreversible. In children, the etiology must be different. It may be a metabolic disturbance, but, if so, it is difficult to explain why one, two, or at the most three, discs only are affected.

Because three of the patients had pyrexia, leucocytosis and a raised erythrocyte sedimentation rate, it has been suggested that the condition might be a metastatic infective process. The normal adult disc is avascular and cannot be primarily affected in haematogenous infections. But in childhood the intervertebral disc is supplied by a number of blood vessels which penetrate the cartilage plate; these undergo slow degeneration early in life, the process being complete by the age of twenty or thirty. Thus the discs in children are connected with the general circulation and a blood infection is possible. The fact that in most of the cases the calcification disappeared quite rapidly certainly indicates an ample blood supply, but it does not confirm the infective theory. In the author's case and in four of the other seven, there was nothing to suggest any infection.

SUMMARY

1. A case of calcification in the intervertebral discs of a child is described.
2. The difference in the condition as it affects children and adults is discussed.
3. The etiology is considered but no definite conclusion is suggested.

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AVASCULAR NECROSIS OF THE FEMORAL HEADS IN A COMPRESSED AIR WORKER

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Chronic joint disease from work in compressed air was first described by Bornstein and Plate (1911-12) and by Bassoe (1911) independently; and necrosis of the shaft of the femur was reported earlier by Twynam (1888). Bassoe (1913) was probably the first to distinguish between trophic bone changes secondary to the cord lesions of caisson disease, and chronic arthritis resulting from the local liberation of gas during decompression. The pathology of bone and joint lesions in compressed air workers was described nearly thirty years later by Kahlstrom and others (1939a), who reviewed the previously reported cases and added four of their own. Pathologically, there is multiple infarction of large or small parts of long bones, with new bone formation and calcification in weight-bearing areas, and later degenerative arthritis, sometimes with loose bodies. In parts of the bone away from the joints there is invasion with new bone formation and then encapsulation with a fibrous wall, which may become calcified and ossified. The bone lesions are usually multiple and have a typical radiographic appearance.

Since 1939 cases have been reported from various countries and it seems that the condition is a not uncommon sequel to work in compressed air, particularly if decompression has been too rapid (Twynam 1888, Gordon and Heacock 1940). Although pain from "bends" in joints subsequently affected by arthritis is common, this is not essential to the later onset of gross arthritis (Bell, Edson and Hornick 1942, Taylor 1944). Bone lesions are characteristically multiple (Coley and Moore 1940, Taylor 1944), and many are clinically silent, particularly those involving the shafts of bones, but if articular surfaces are involved there are usually symptoms (Swain 1942, Allan 1943). Long periods may elapse between exposure to high pressure and the onset of symptoms, and also between the onset of symptoms and diagnosis (Kahlstrom *et al.* 1939a, Walker 1940). The correct diagnosis depends on a complete occupational history that includes the whole working life, for exposure to compressed air may have occurred many years before and it is probable that the true origin of many of these cases is not recognised at all. Similar lesions are sometimes seen in patients who have never worked in compressed air (Kahlstrom *et al.* 1939b, Kahlstrom 1942, Taylor 1944), but these are less likely to be multiple. The pathogenesis of these cases is obscure and fat embolism or arteriosclerosis of nutrient vessels has been suggested as a possible cause. In compressed air workers it is suggested that injury plays a part in selecting the site for major lesions, and Gordon and Heacock (1940) asserted that the predilection for the hip and shoulder regions supports this. We cannot believe that the hip and shoulder are more often subjected to trauma than, for instance, the knee, but there can be no doubt that once infarction has occurred, trauma, or even normal weight-bearing, will influence the extent and nature of the destruction.

There is at present no agreement on the pathogenesis of avascular necrosis found in compressed air workers. Nitrogen emboli in the vessels of the epiphysis have been suggested, or gas formation in the intramedullary fat. Experimental rapid decompression of rabbits produces cavity formation in the bone marrow from nitrogen bubbles, and this may be an early stage in the process (Colonna and Jones 1948). Behnke (1951) thought that the casual

relationship between the lesions and embolic injury must be supported by further experiments and pointed out that in divers suffering repeatedly from experimental "bends" radiological bone changes have not been observed. In this instance the follow-up may not have been long enough.

Few of the reported cases have been treated except by symptomatic means. Arthrodesis and removal of part of the head of the femur has been performed (Walker 1940) and in another case a reconstructive operation on one hip (Rendich and Harrington 1940), but little detail is given.

There have been only two published reports from Great Britain of bone lesions after decompression, the first in a caisson worker who died from coronary thrombosis (Swain 1942). Necropsy was performed and he was found to have avascular necrosis of both humeri. There had been pain in the right hip in life but this was not examined. The second report described three survivors of a submarine disaster in whom radiographic bone changes were found twelve years later. In one man there was collapse of both femoral heads with osteoarthritis. These cases are of great interest because they all developed after a single decompression (James 1945).

THE TYNE TUNNEL

Between 1948 and 1950, while a tunnel was being constructed under the river Tyne between Howden and Jarrow, leakage of water through a porous river bed necessitated working in compressed air, at a pressure of about 35 pounds a square inch. Precautions as laid down in the Provisional Revised Draft (June 1948) of Regulations as to Safety, Health and Welfare in connection with Work of Engineering Construction (Factories Act, 1937) were taken to ensure proper decompression of all men leaving the tunnel. The incidence of "bends" was less than 2 per cent per week and a separate medical lock was used for its treatment. There were two serious cases of paraplegia, and the unusual circumstances in which they occurred are described elsewhere (McCallum and Walder 1953). Since then, one man has developed severe hip joint disease and this case is described here.

CASE REPORT

A caulker, aged 30 years, first attended in May 1950, complaining of aching pains from below the knees to the hips. They began gradually about six weeks before and were most severe in the front of the thighs, especially the right, with stiffness of the legs and difficulty in walking. Apart from these pains he was perfectly well, and his only previous illness of note was malaria. His previous employment had been that of a truck driver, and he had done six years of military service. He had also spent four months in the Battersea Tunnel at a pressure of 8 pounds a square inch, without ill effects. He stated that whilst employed on the construction of the Tyne Tunnel he had suffered from "the niggles*" on several occasions. In about ten months he worked 272 shifts, each of about six hours, followed by decompression lasting one hour and three-quarters. He had "bends" on three occasions, after 68, 114 and 126 decompressions respectively. These attacks occurred after work at pressures of 35-40 pounds a square inch, and they consisted of stabbing or aching pains in the thighs and knees, mainly on the right side, which came on up to nine hours after decompression and were relieved by recompression for five or ten minutes. On the last occasion pain recurred two hours after recompression and he had to return to the medical lock a second time. Shortly after he had ceased working in compressed air altogether, he had felt a weakness in the right knee with slight stiffness in the hips and thighs, and a sensation of loss of balance, but he thought little of it at the time.

On examination his general condition was good and there was no wasting of limbs or trunk. He walked with a stiff spastic gait, turning in the toes, and had difficulty in getting

* "The niggles" is a term used by compressed air workers for the pains of a mild attack of "bends."

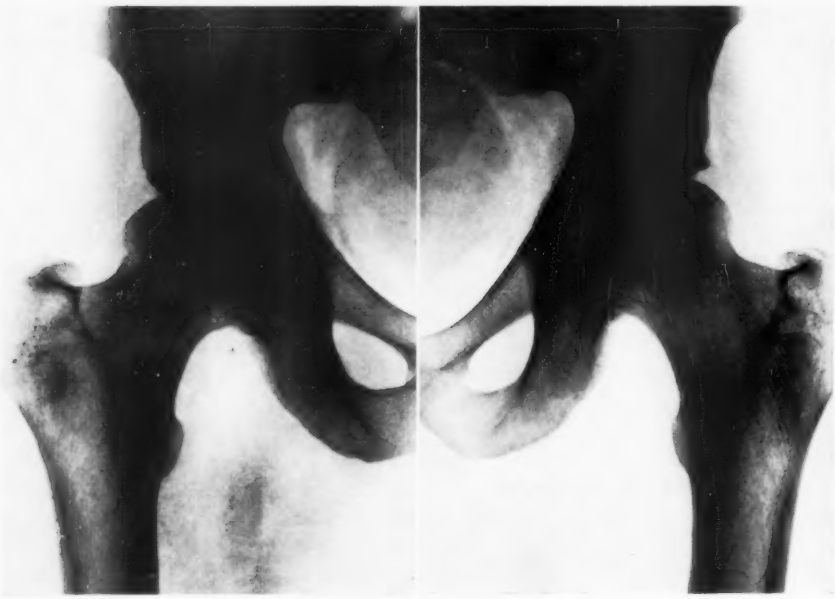

FIG. 1
Initial radiograph of hips, taken six months after the patient had ceased working in compressed air.

FIG. 2
Condition twenty-one months later.

on or off a couch, or in sitting up from the lying position. Passive movements of the lower limbs produced pain in the groins and knees and the limbs felt stiff. No abnormality was found in the lungs, heart, or alimentary system; the blood pressure was 135/70 and the central nervous system was normal, with brisk but equal limb reflexes. There was no fever, and the blood sedimentation rate was only 3 millimetres (Westergren). On radiography six months after he had left compressed air work the femoral heads were thought to be normal (Fig. 1). No definite diagnosis was made at that time and he was given symptomatic treatment with massage and exercises to the lower limbs.

There seemed to be some temporary improvement after this, but later the pain and disability became worse until his legs became so weak that he could not flex them. On one occasion he fell down and could not get up. In February 1952, twenty months after the onset of symptoms, further radiographs showed marked arthritis of both hips, and orthopaedic advice was sought. His general condition was still good, but the man was severely disabled. He could just manage to move about with the aid of crutches, but had to be helped into and out of a chair.

FIG. 3
Drawing of the left femoral head removed at arthroplasty.

Movement of the hips caused severe pain. The range on the right side was: flexion 30 degrees, abduction nil, adduction 5 degrees, rotation nil. On the left side there was flexion 70 degrees, abduction 50 degrees, adduction 30 degrees, rotation nil. Radiographs showed gross destructive changes in the heads of both femora. The right acetabulum was normal, and the only change in the left was a minor degree of lipping of the upper margin. Though the changes extended throughout the femoral head, the greatest deformity of the articular surface was on the superior aspect, which is normally subjected to the greatest weight-bearing pressure. The radiological findings resembled those seen in avascular necrosis from severe damage to the blood supply to the femoral head (Fig. 2), and were not at that time characteristic of osteoarthritis. This, together with the history of work in compressed air, suggested a diagnosis of caisson disease of the hips. Radiographs of the rest of the skeleton showed no other lesions.

Treatment—In May 1952 a Judet acrylic arthroplasty was performed on the left hip, through an anterior Smith-Petersen approach. The capsule was found to be greatly thickened and the synovial membrane was villous. The joint cavity contained an excess of synovial fluid and several small cartilaginous loose bodies. The femoral head (Fig. 3) was distorted, the articular cartilage degenerate and, in parts, necrotic, and there was marginal lipping, but the acetabulum appeared to be little affected. The capsular and synovial tissues were excised as completely as possible, and after replacement of the femoral head with the prosthesis the joint seemed stable (Fig. 4). The patient made an uneventful recovery. In July 1952 a similar operation was performed on the right hip, with similar findings. When his rehabilitation was completed, in December 1952, the patient had no pain in either hip, and flexion was limited by only 20 degrees. Since then he has worked regularly as a bus driver.

Pathological examination—The right femoral head was flattened, with a central shallow depressed area of irregular outline covered by thin cartilage. There was considerable osteoarthritic lipping. Section showed an area of avascular necrosis corresponding to the surface depression; it had the characteristic wedge-shape of an infarction, and this was confirmed microscopically. There were no gross changes in the arteries of the ligamentum

teres. The appearances were those of avascular necrosis such as may be found in caisson disease.

DISCUSSION

Avascular necrosis of bone may occur from time to time without known cause, but the onset of severe destructive changes in the femoral heads of a man of 30 within twenty-one months of work in compressed air suggests that this was the direct cause. Pain in the hips began only five months after his work in the tunnel had finished, and while working in the pressure he had " bends " affecting both lower limbs, though not to a degree that could be considered unusual in a compressed air worker.

The prevention of bone disease in compressed air workers depends partly on a fuller understanding of the pathogenesis. Some cases have resulted from too rapid compression

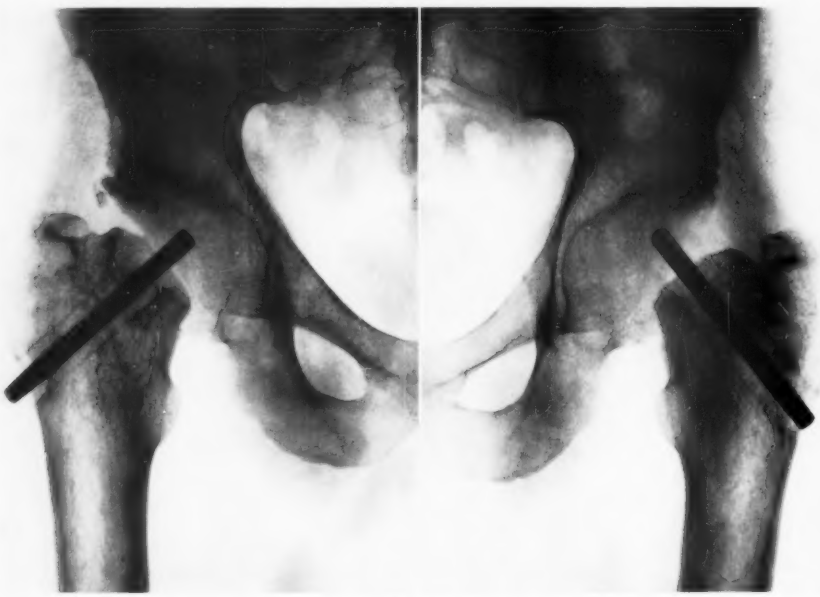

FIG. 4
Radiograph of hips after bilateral Judet arthroplasty.

and they emphasise the need for strict control of decompression procedures and for a high standard of discipline among the workers. Prevention is made more difficult because bone changes can occur without previous " bends " or after a single rapid decompression. Decompression of our patient was carried out according to regulation, but it is probable that bone lesions, like other forms of decompression sickness, cannot be prevented entirely by decompression according to standard tables, and that individual susceptibility plays a part. It is possible that bone disease occurs more frequently than is recognised; and, in cases of unexplained avascular necrosis, particularly in the humerus or femur, a history of work in compressed air should be enquired into.

It has been suggested (Milne 1948) that if all joints in which an attack of " bends " had occurred were always examined radiologically eight or ten weeks afterwards, the condition could be detected, and that immobilisation of the joint might lead to revascularisation of the sequestrum with complete cure. Brailsford (1944) stated that radiographs might show

evidence of disturbance of the vascularity of a fragment of bone within six weeks of the causal incident, but one of us (J. K. S.) has recognised such evidence at three weeks.

It is noteworthy that six months after this patient ceased work in the tunnel, at a time when he was already suffering severe pain, the radiograph of the hips (Fig. 1) showed no abnormality, but twenty-one months later gross changes in both femoral heads were apparent (Fig. 2). From our experience of avascular necrosis in bone from other causes (for instance, osteochondritis dissecans), immobilisation of the joint and protection from weight bearing is not a practical possibility, because complete revascularisation, if it ever occurs, would probably take years rather than months.

Judet arthroplasty is of particular value in a case of this type because the femoral head has been destroyed, and therefore cup arthroplasty is impracticable. Furthermore, it is undesirable to sacrifice the articular cartilage of the acetabulum which, in the early stages of this condition, is little affected. The Judet arthroplasty permits complete study of the damaged femoral head, previously impossible. However, although arthroplasty is undoubtedly the operation of choice in bilateral disease, arthrodesis might still be the correct procedure in a unilateral case.

The material for this paper has been gathered from many sources and the authors wish to acknowledge their indebtedness to the heads of the Departments of Orthopaedics, Industrial Medicine, Radiology and Pathology in the Royal Victoria Infirmary, Newcastle-upon-Tyne, and to the Medical Research Council Unit investigating decompression sickness.

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RECURRENT DISLOCATION OF EXTENSOR TENDONS IN THE HAND

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Dislocation of a tendon of extensor digitorum from its median position on the metacarpal head during flexion of the metacarpo-phalangeal joint is a rare occurrence, though from its exposed position it will not often pass unnoticed. Sir James Paget mentioned three cases in 1875 and Marsh a further four in 1896, since when its pathology and treatment have received occasional mention and discussion. Usually the report has been on the basis of a single personal case.

The following cases are of interest in that the nature of the primary lesion is demonstrated, together with a satisfactory method of operative repair. Other methods of treatment and the probable etiology are briefly discussed.

CASE REPORTS

Case 1—A sixteen-years-old boy gave a history of having sustained a sharp blow on the dorsum of the proximal phalanges of his right hand six years before, when holding a toy gun. Since then, the extensor tendon on the third metacarpal head had been dislocating to its ulnar side each time the metacarpo-phalangeal joint was flexed, and returning to the normal position when it was extended. This had caused few symptoms until recently, when an increased amount of writing had been followed by aching and throbbing in the affected knuckle. On examination, the dislocation of the tendon with flexion of the joint was obvious. The function and anatomy of the hand were in other respects normal.

Operation—Exploration through a longitudinal incision revealed an oblique tear in the radial side of the proximal border of the extensor aponeurosis (Fig. 1) which allowed the tendon and aponeurosis to slip off the metacarpal head as the joint flexed, leaving it covered only by synovial membrane and extra-synovial connective tissue (Fig. 2). The aponeurosis was sutured, but with flexion of the finger the sutures cut out and the dislocation recurred. A conveniently situated junctura tendinum was therefore separated from its attachment to the ring finger tendon and brought over to be sutured down in the line of the torn aponeurosis (Fig. 3). This effectively prevented any further dislocation (Fig. 4). After suture of the skin the digit was immobilised on a plaster splint in a position just short of full extension for three weeks. The finger soon regained a full range of movement and normal strength. There was no sign of recurrence one year later.

Case 2—A twenty-eight-years-old woman injured her left hand thirteen years ago when jumping over a vaulting horse. The hand was wrenched as she continued to hold on to the horse after her body had passed over it. She sustained a greenstick fracture of the fourth metacarpal, and the whole hand was bandaged up with the fingers fully flexed for two weeks. She remembers that it took a long time and much effort before she recovered a full range of movement in her fingers. Since then, she had noticed the extensor tendon of the ring finger occasionally slipping to the ulnar side of the knuckle, and to this she attributed aching discomfort between the fourth and fifth metacarpal heads after much work with the fingers, as in dentistry or piano playing.

On examination, a partial dislocation of the ring finger extensor was produced fairly easily by resisting the patient's attempt to extend the partly flexed finger while forcing it a few degrees towards the ulnar side (Fig. 5). The photograph shows that the middle finger tendon was also unstable and moved well to the ulnar side of its knuckle.

FIG. 1

FIG. 2

Case 1—The condition found at operation with the metacarpo-phalangeal joint in extension (Fig. 1) and in flexion (Fig. 2).

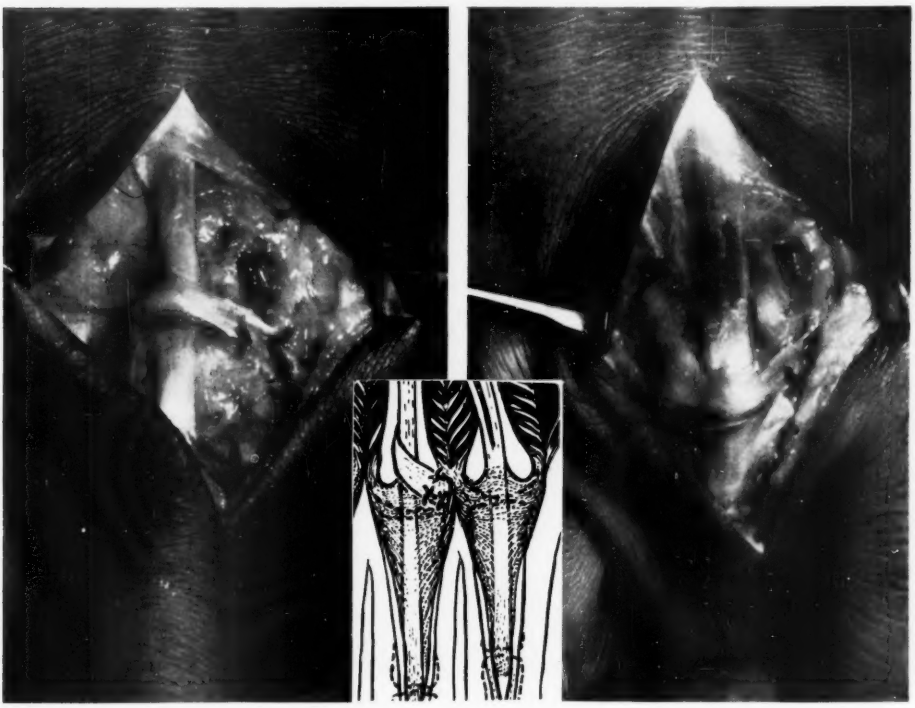

FIG. 3

FIG. 4

Case 1—After repair with junctura tendinum from the radial side of the tendon. Figure 3—Finger extended. Figure 4—Finger flexed. Inset shows details of the repair.

The discomfort produced in this patient was less than in the first case because the tendons did not invariably dislocate with flexion of the joint and because the smaller prominence of the knuckles of the female hand considerably reduced the range of abnormal movement.

DISCUSSION

Anatomy—The metacarpo-phalangeal joint is a simple diarthrodial hinge joint with a small range of lateral movement in extension which diminishes to none in full flexion. It has strap-like lateral ligaments and a thick fibrocartilaginous palmar ligament. The dorsal capsule is completed by the extensor aponeurosis, formed from the common extensor tendon and the lateral expansion and the insertions of the lumbrical and interosseous muscles, the whole being separated from the synovial membrane by a loose layer of areolar tissue which permits free movement in the line of the tendon. The interosseous muscles usually have attachment also to the base of the proximal phalanx and a slip to the ligaments of the adjoining joint (Bunnell 1942). With the finger extended the extensor aponeurosis ends proximally with a clear-cut curved border one centimetre proximal to the joint line; in flexion it moves distally to lie opposite the middle of the articular surface on the end of the metacarpal. Proximal to this, on the dorsal surface of the hand, the tendon lies in loose areolar tissue between skin and deep fascia; here the only checks to its lateral movement are oblique and transverse tendinous and fibrous bands of varying size and strength.

FIG. 5

Case 2—This dislocation could be produced only by resisting the patient's attempt to extend the finger from flexion and ulnar deviation.

Etiology—The dislocation arises because of abnormalities in the shape of the extensor aponeurosis, and these may be traumatic, congenital or pathological in origin. Any one or a combination of these factors may be present in a particular case.

Injury—In the recorded cases the patients have most often given a history of a violent blow on the dorsum of the incompletely flexed fingers, forcing them into ulnar deviation. Curchod (1916) reported the case of a man who wrenched his fingers into ulnar deviation when falling, as in Case 2. Direct injury to the knuckle has not been a factor in these cases, except possibly in that of Razemon (1930), in which the condition was caused by a left hook when boxing; but it is equally possible that this man may have punched with his fist incompletely clenched.

While studying the anatomy of this region in preserved hands, I have been able to reproduce exactly the lesion seen in Case 1 by forcing flexion and ulnar deviation of the metacarpo-phalangeal joint against the resistance of the formalin-hardened extensor muscles. This lesion is an oblique longitudinal tear in the proximal border of the extensor aponeurosis (Fig. 6). It is not longer than half a centimetre, but in two hands, from different subjects, it was similarly produced and was followed by a typical tendon dislocation (Fig. 7). Ulnar deviation is essential to the production of the lesion, for in the hands examined the tendon was not dislocated when the fingers were flexed with their long axes remaining in the line of the proximal part of the tendon, even after the aponeurosis was torn. It is interesting

that as the stability of the tendon on the knuckle appears to diminish with flexion of the joint, there is a decrease in the range of lateral joint movement.

It seems probable, therefore, that most traumatic lesions are produced by a force which causes further flexion and ulnar deviation of the already partly flexed metacarpo-phalangeal joint when the opposing extensor muscles are contracting strongly.

Congenital anomalies—There is much variation, both in size and shape, between tendons in the same and in different hands. That this may be a factor favouring dislocation is suggested by the different incidence of dislocation in different fingers. Of thirteen recorded traumatic tendon dislocations, Razemon (1930) found that ten had occurred in the middle finger and three in the index fingers. Thus it may be presumed that the tendons in the radial two fingers are less stable than those in the ulnar pair—perhaps from differences in shape, or from the normal ulnar deviation of the radial fingers when they are adducted to the midline. However,

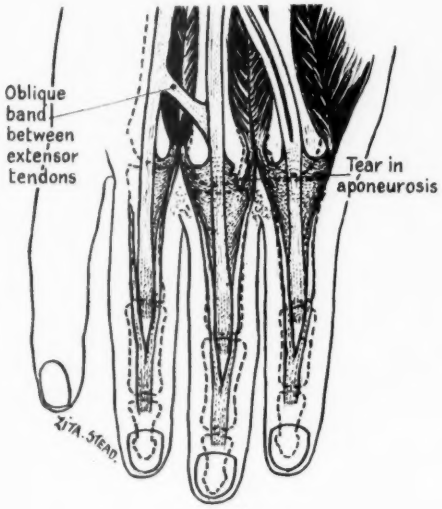

FIG. 6
Diagram to show lesion produced experimentally. The size of the tear in the aponeurosis has been slightly exaggerated.

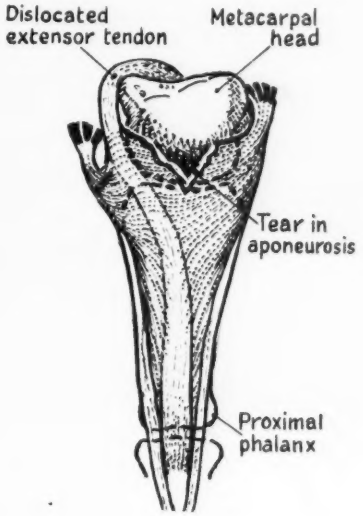

FIG. 7
Appearance of the knuckle with the metacarpo-phalangeal joint flexed to 90 degrees.

the deviation is greater in the index than the middle finger, whereas dislocation is commoner in the middle finger; so the shape is probably the more important factor. As they pass over the knuckles it is usual for the index, ring and little finger tendons to be broad, usually double, ribbons which embrace the metacarpal head with little tendency to dislocate. The tendon to the middle finger is usually more round in cross-section and is seated more precariously on the bony prominence. This state of affairs occasionally exists in the tendons of the other three fingers.

These variations are not in themselves sufficient to cause dislocation, or it would occur more commonly than it does. There must, in addition, be some variation in the shape or position of the extensor aponeurosis and in most cases on record there is a history of injury. Fitzgerald (1939) ascribed lesions affecting all four tendons in one hand to an excessively distal siting of the aponeurosis on the extensor tendon; and Levy (1921) reported a family in which grandmother, father and daughter all had extensor tendon dislocations, the daughter having dislocated the tendons to the ring and middle fingers in one hand, as in Case 2. Another congenital example unassociated with severe injury may be that reported by Straus

(1940) in which the dislocation occurred from resting the weight of the body on the dorsum of the partly flexed fingers on a table.

Pathological changes—The degenerative changes of rheumatoid arthritis may allow the extensor tendons to dislocate (Fig. 8). Fearnley (1951) stated that dislocation is usually seen only in advanced cases with much ulnar deviation and stressed that it is the result and not the cause of the ulnar deviation. However, in Levy's case, attributed to rheumatoid arthritis, there was only swelling of the joints without severe deformity, and, six years after the dislocation, the patient still had a full range of normal movement in the metacarpo-phalangeal joints. It is, of course, quite possible that the dislocation was coincidental in this patient, in that she had a tendon which was congenitally unstable before the development of the arthritis. It is a fact, however, that in a number of the recorded traumatic cases the patient has complained of ulnar deviation of the affected finger when the tendon was dislocated, and one would expect that the coincidence of traumatic or congenital dislocation with arthritis deformans would hasten the development of the characteristic arthritic deformity.

FIG. 8
Museum specimen of tendon dislocation in the ulnar deviation of rheumatoid arthritis.

Treatment—Many persons with this condition probably do not find it sufficiently troublesome for them to seek medical advice; others, as in Case 2, become so accustomed to the occasional pain and discomfort that they prefer it to the inconvenience and uncertainty of operation. None of Levy's four patients wished to have the hand treated, and Mouchet (1942) did not advise any treatment in his case, in which the tendon remained permanently dislocated and caused no symptoms.

Most patients with traumatic lesions probably complain of some pain and discomfort at times, and in some there is difficulty in completing the movement of extension until the tendon snaps or is pushed back into its normal position. They may also complain that when the tendon is dislocated it pulls the finger into ulnar deviation, in which position it interferes with the movement of the adjoining finger. These patients are generally glad to get some relief from their symptoms.

Curchod (1916) and Silfverskiöld (1928) each reported a case in which the metacarpo-phalangeal joint was immobilised in extension immediately after the injury, with subsequent return of normal function without symptoms; though in each case a slight recurrent subluxation of the tendon remained. It may not always be easy to recognise this lesion in the presence of haematoma and swelling immediately after the injury; but the operative approach is so simple that when the condition is recognised it would be reasonable to make a small incision and to restore the anatomy to normal with two or three sutures before applying the splint.

Haberern (1902) dissected the tendon from the aponeurosis and reattached it to the radial side with a flap from the ulnar side sewn over the tendon. Success with this method has also been recorded by Razemon (1930) and Straus (1940). Bunnell (1948) prevented

dislocation by simple radial transplantation of the tendon on the aponeurosis and it seems probable that the flap in Heberern's operation is unnecessary.

Repair or replacement of the defective half of the proximal border of the aponeurosis may be accomplished with any suitable tissue available. Bunnell threaded a length of palmaris longus tendon across the extensor tendons, suturing down the graft midway between each tendon; and Fitzgerald (1939) and Cutler (1942) used a strip of fascia for a similar purpose. The use of some locally available tissue is less mutilating and less troublesome, and the vinculae, where available, are an obvious choice. Failing this, a strip of the tendon itself turned down and across should be sufficient to effect the repair without in any way interfering with the normal function of the joint or tendon.

My thanks are due to Mr B. H. Burns and Mr R. H. Young for permission to report Case 2 and for their help and encouragement. I am extremely grateful also to Mr Guy Pulvertaft for his help with the preparation of this paper and to Professor T. Nicol of King's College, London, for allowing me to study specimens in his department, to Dr N. Haidu for his translation of the papers in German to which I have referred, to Professor T. Crawford for permission to photograph the specimen in Fig. 8 in the Museum of the Pathological Department, St George's Hospital, and to the Photographic Department, St George's Hospital, for the clinical photographs.

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SPRAIN OF THE PISIFORM-TRIQUETRAL JOINT

Report of Six Cases

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Perhaps the least satisfactory diagnosis in painful conditions of the wrist is that of tenosynovitis. In the first four patients in this series a diagnosis of tenosynovitis of the flexor carpi ulnaris was made, but their failure to respond to the usual conservative measures stimulated further investigation. The tests herein described, and the response to operative fusion, suggest that sprain of the pisiform-triquetral joint is the true pathology of this uncommon condition.

CLINICAL FEATURES

Six patients suffering from persistent pain in the region of the pisiform bone were seen in a busy surgical out-patient department during a period of two years. The pain was described as aching in character, and was either brought on or made worse by exertion, especially heavy lifting. The insertion of flexor carpi ulnaris was indicated as the site of greatest pain.

TABLE I

Summary of Cases

Case	Age	Duration of symptoms	Side affected	Mode of onset	Treatment	Result	Date last seen
1	18	2 years	Right	Insidious	Plaster 2 months Exploration 15.8.50 Re-exploration 22.6.51 Fusion without internal fixation 24.10.51 Excision of pisiform 10.11.52	No relief Relieved for 3 months Temporary improvement Painful fibrous union Relieved	6.1.53
2	28	1 year	Right	Followed fall	Plaster 10 weeks Excision of pisiform 24.1.50	No improvement Relieved	24.12.52
3	20	1 year	Left	Insidious	Plaster 4 weeks Operation refused 10.4.51	Temporary improvement	29.8.52
4	30	3 weeks	Right	Followed fall	Plaster 6 weeks Fusion with internal fixation 31.4.52	No improvement Relieved	13.8.52
5	28	3 months	Left	Blow on wrist	Fusion with internal fixation 30.11.51	Relieved	5.11.52
6	18	4 years	Right	Blow on wrist	Fusion with internal fixation 30.11.51	Relieved	4.9.52

All six patients were women between the ages of eighteen and thirty, and the dominant hand was affected in each one. Four patients gave a history of injury, two from a fall and two from a direct blow on the front of the wrist. Three patients had pain referred to the fifth finger, and a fourth complained of weakness of the medial two fingers on heavy lifting. The clinical features are summarised in Table I. The disability tended to be most severe in the manual workers but interfered with work in all patients except in Case 3. In Case 4 the pain was so severe that the patient was unable to lift a teapot.

On clinical examination a constant finding was pain on resisted flexion of the wrist,

greatest in the position of ulnar deviation. Pain was also elicited when the patient held a heavy object in the outstretched hand with the forearm in full supination. In both these tests the pain was centred round the pisiform bone, and this suggested that the flexor carpi ulnaris insertion was the probable site of the lesion. More accurate localisation of the source of the pain followed the discovery that passive movement of the pisiform bone on the triquetrum elicited pain of the same character as that complained of. The pisiform can normally be displaced laterally on the triquetrum in the position of ulnar deviation of the hand when the muscles are relaxed. Pain on this test is diagnostic of sprain of the piso-triquetral joint, and in two cases movement was accompanied by crepitus. Three patients who were given an injection of local anaesthetic into the affected joint had relief of pain for the duration of the anaesthesia. In none of these patients did radiological examination reveal any abnormality.

TREATMENT

In view of the chronicity of the condition and its failure to respond to prolonged immobilisation and physiotherapy, operative intervention seemed to be indicated. In Case 1

FIG. 1

Case 4—Radiograph three months after operation showing fusion of the pisiform-triquetral joint.

two attempts were made to rest the affected joint by dividing the tendinous slip attaching flexor carpi ulnaris to the pisiform, leaving the tendon to glide freely over the bone. Temporary relief of up to three months followed, but in both cases the symptoms recurred. Therefore in Case 1 arthrodesis of the pisiform-triquetral joint was undertaken. The joint surfaces were simply excised, and no internal fixation was used, for it was hoped to avoid inserting a metallic foreign body in such close proximity to the wrist joint. But the operation led to a painful fibrous union and ultimately the pisiform was excised with relief. In Case 2 the pisiform was excised. The final result was good but recovery was delayed by involvement of the ulnar nerve in scar tissue, which necessitated a second operation for its relief.

In Case 3 the symptoms were considered to be severe enough to justify operation but the patient refused it. Temporary improvement followed immobilisation in plaster for one month. When seen sixteen months later she continued to have pain which was worse after carrying, lifting, and riding a bicycle.

In Cases 4, 5, and 6 treatment was by excision of the joint surfaces and internal fixation

METAPHYSIAL DYSOSTOSIS

Report of a Case

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In 1934 Murk Jansen described an unusual case of skeletal growth disturbance under the title of " Metaphysial Dysostosis." No other example of the condition appears to be on record, although Fairbank (1951), in describing the features of Jansen's case, briefly referred to two others which had been brought to his notice by Dr Norah Walker and Mr G. M. Müller. These, though not strictly comparable with Jansen's case, showed widespread metaphysial lesions of a somewhat similar type. In an account of the second of these cases published later by Müller and Sissons (1951) it is stated that the radiographic changes present, although showing some similarity to those in Jansen's case, were consistent with a diagnosis of renal rickets, and that the histological findings in the abnormal bones were those of renal osteodystrophy with the high degree of secondary hyperparathyroidism that Gilmour (1947) described as characteristic of these cases.

The present case is published as an example of metaphysial dysostosis in which no evidence of a relationship to renal disease can be found on careful study, including clinical, radiological, biochemical and biopsy investigation. The case appears to be the only classical example of metaphysial dysostosis that has been described since Jansen's report in 1934, and is placed on record for this reason.

CASE REPORT

A Chinese boy aged seven years was seen on account of deformity of both lower limbs. The deformity had been noticed first after he began to walk at about the age of twenty months. Soon afterwards deformities of the chest and of the upper limbs were observed. The early history was that pregnancy was uneventful and went to full term. The infant raised his head at four months, sat up at six months, and walked at twenty months. He was breast-fed for seventeen days and then weaned because of fever and convulsions which lasted a week: artificial feeds were given for three years. Other illnesses recorded in his early life were pneumonia at six weeks and vesicles on both feet and palms without pyrexia at seven months.

Family history—The mother and father were alive and apparently normal. There were two older brothers and a sister, all normal. There was no history of deformity in other members of the family.

Condition on examination—The child weighed $32\frac{1}{2}$ pounds and measured $33\frac{3}{4}$ inches in height. His general appearance is shown in Figures 1 and 2. The circumference of the skull was $20\frac{1}{2}$ inches. The head appeared to be slightly enlarged in its transverse diameter in the tempero-parietal region. The face was normal with slightly protuberant eyes. There was a tendency to nasal catarrh. Hearing was normal. There were no signs of thyroid enlargement. The ribs showed a " rosary " at the costo-chondral junctions. The fingers were " clubbed "; although the proximal ends of the phalanges were enlarged, the range of joint movements was full. The lower limbs showed marked genu valgum with anterior bowing of the femora, rotation of the tibiae, and angulation at the lower ends of the tibiae. The ends of all long bones were enlarged and deformed. Normal findings were obtained on examination of other systems.

Radiographic appearances—There was a marked disturbance of the normal processes of bone growth and development, and this was most pronounced in areas where growth is normally most active. The disorder appeared to be restricted to the metaphysial side of the

FIG. 1

FIG. 2

Photographs of the child at the age of seven years.

FIG. 3

FIG. 4

FIG. 5

Figures 3 and 4—Photographs of the child showing the appearance two years after corrective osteotomies to the femora. Figure 5—Photograph of the hands.

growth cartilage and in the long bones extended into the adjacent terminal spongiosa. In the flat bones of the pelvis and shoulder girdle the bone in the neighbourhood of the acetabulum, sacro-iliac joints, crest of the ilium, and glenoid was most affected. In some bones the

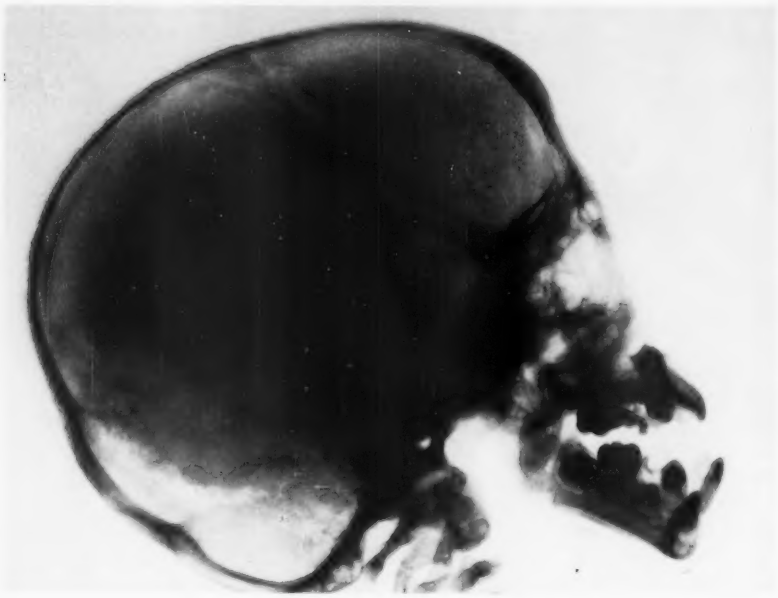

FIG. 6
Skull.

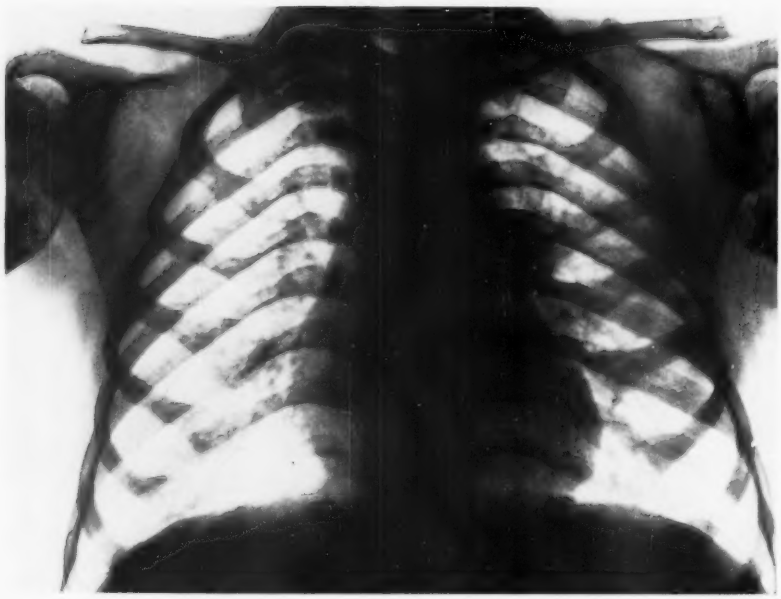

FIG. 7
Thorax.

FIG. 8
Pelvis and upper ends of femora.

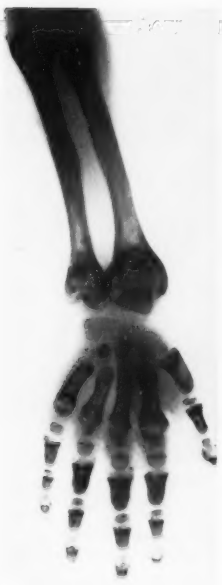

FIG. 9

FIG. 10

FIG. 11

Figure 9—Left forearm and hand. The right side was similarly involved. Figure 10—Right tibia and fibula. The left side was similarly involved. Figure 11—Left foot. The right side was similarly involved.

metaphysis ended in a crenated line of increased density. The epiphysial bone centres that were visible had not been affected, nor had the bony centres of the bones of the tarsus and carpus that were present. The greater part of the spinal column was normal in appearance, and so was the vault of the skull.

The ends of all the long bones were expanded to a greater or lesser degree as if the process of remodelling had failed (Figs. 8, 9, and 10). In some bones this expansion was very pronounced and the bone had the shape of a club. The expanded ends were cupped, the amount varying in different bones, but in some cases being sufficient to enclose the greater part of the corresponding epiphysial bone centre. The walls of the cup were formed of sclerotic thickened bone and in some bones appeared to be fragmented or possibly fractured. The bottom of the cup was formed by a zone of fairly dense irregular interlacing trabeculae, which seemed to be compressed so that an area of increased density demarcated the abnormal bone from bone of apparently normal structure in the diaphysis. The cupped expanded ends of the bones appeared to contain a material of soft-tissue density in which there were scattered irregular areas of density which in some bones resembled isolated fragments of dense bone; in others amorphous calcification; and in others punctate calcification. In the lower end of the radius and ulna there was a mosaic pattern of soft-tissue densities separated either by irregular transradiant lines or lines of increased density (Fig. 9). The femora were bowed anteriorly to a marked degree. The tibiae and fibulae also appeared to be bowed, but the deformities were caused not so much by bowing of the shafts as by angulation at the junction of the disordered hyperplastic metaphysis and the shaft. At sites where angulation had occurred there was increased bone density most marked on the concave side. The shafts of the long bones were thicker than normal; but their cortices were not particularly thickened, except at sites of bowing where there was definite buttressing, as in the tibiae where cortical buttressing extended all along the posterior and medial parts of the shafts (Fig. 10).

The distal bones of the limbs appeared to be a little short relative to the length of the proximal bones, and the fibulae appeared short in relation to the tibiae. The small long bones of the hands and feet were shorter and broader than normal so that the hands had a stumpy trident appearance and the feet appeared wide and short (Figs. 9 and 11). They exhibited metaphysial changes similar to those occurring in the long shaft bones, and were interesting in that, although in the distal and middle phalanges cupping and loss of density were the most marked features, in the proximal phalanges islands of slight density could be seen within the cups, and in the metacarpals these islands appeared still denser as if bone had at last been laid down in them.

The anterior ends of the ribs and the inner ends of the clavicles were expanded and cupped and showed changes similar to those described in the long bones (Fig. 7). The spinal column was of normal length, and the vertebral bodies and discs were of normal size and shape except for a localised section of the spine—T.11, 12; L.1, 2—in which there was an irregular increase in the density of the anterior borders and the anterior thirds of the upper and lower margins of the vertebral bodies. In the pelvis the acetabula were deformed and enlarged and there was a marked irregularity of its bony margins which seemed to be composed of dense nodules of bone and thickened interlacing trabeculae intermingled with clear areas (Fig. 8). The triradiate cartilage was thicker than normal and the femoral capital epiphyses were separated from the bony bases of the acetabula by distances greater than normal. The bone bordering the sacro-iliac joints and along the crests of the ilia showed similar changes. There was a wide separation between the ossified ramus of the ischium and the inferior ramus of the pubic bone.

The skull was large and brachycephalic. The calvarium was of normal thickness (Fig. 6). The mastoids were fairly well pneumatised but the body of the sphenoid was opaque and showed no evidence of pneumatisation. Although there was a suggestion of the rudiments of the anterior clinoid processes there was no evidence of a pituitary fossa, dorsum sellae or

posterior clinoids. There was an abnormal separation of the bones at the spheno-occipital suture. The frontal and maxillary air sinuses were underdeveloped, and, although the orbits were separated more than usual, the posterior and middle ethmoid cells were underdeveloped.

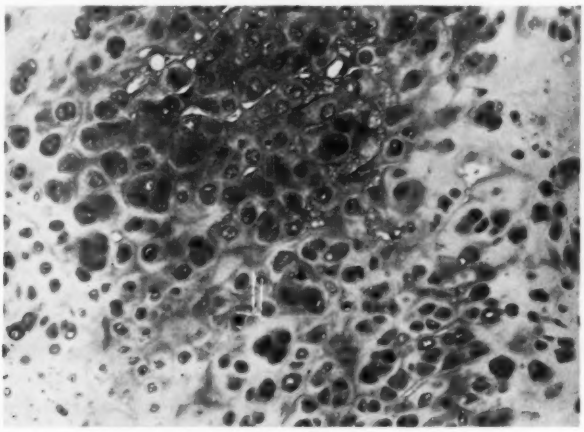

FIG. 12

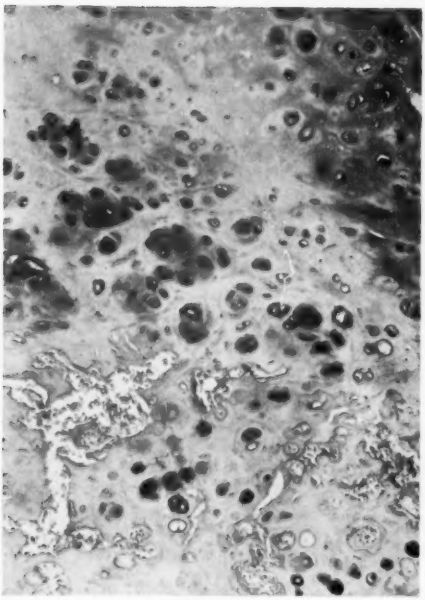

FIG. 13

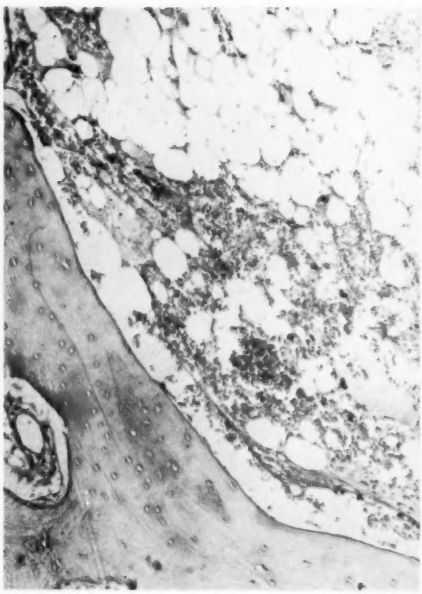

FIG. 14

Figure 12—Histological appearance of the abnormal cartilage present in the metaphysial region. Note the irregular arrangement of the cartilage cells, and the absence of basophilic staining of the intercellular matrix. (×105). Figure 13—Histological appearance of the abnormal cartilage present in the metaphysial region. Occasional clusters of cartilage cells surrounded by basophilic matrix are present, and patchy vascularisation is seen in the lower part of the field. (×105.) Figure 14—Bone and bone-marrow. Bone trabeculae do not show osteoid borders, and there is no " osteitis fibrosa " in the marrow spaces. (×105.)

The development of epiphysial and other centres of ossification in the hands and feet was markedly retarded. Although the child was seven years of age only four tarsal bones were visible—the calcaneum, talus, cuboid and third cuneiform. The epiphysial centres for

most of the phalanges were present but centres for the metatarsals, other than the first, had not appeared. In the hands the centres for the capitate and hamate were well developed but no other carpal bones were visible. The epiphysial centres of the phalanges were all apparent. This degree of development corresponds to that of a normal Chinese boy of two and a half years: epiphysial centres of the long bones that were present in our patient also correspond with this skeletal age. An interesting feature is that all the epiphyses and bone centres that were present were well developed, as if development had proceeded normally up to the age of about two and a half years and that subsequent endochondral bone growth had become disordered and no further epiphysial bone centres had appeared.

Biochemical investigations—Urine and blood analyses were carried out on a number of occasions, with the following results. The urine showed no abnormality except for a trace of albumin. There was no evidence of glycosuria or amino-aciduria. Urea concentration tests gave normal results. Excretion of 17-ketosteroids was normal for age. Haemoglobin was 98 per cent, and white blood corpuscles 7,400 per cubic millimetre. Differential blood count was normal. Blood urea was 23–31 milligrams per cent; serum calcium 10·0–13·7 milligrams per cent; serum inorganic phosphorus 3·4–4·9 milligrams per cent; and serum alkaline phosphatase 16–20 King-Armstrong units per 100 millilitres. The Kahn test was negative.

Histological examination—The biopsy specimen (about $1 \times \frac{1}{2}$ inch in size) from the metaphysial region of the lower end of the femur consisted of irregular masses of abnormal epiphysial cartilage, together with some adjacent cortical and cancellous bone. The abnormal cartilage (Figs. 12 and 13) showed wide areas of degenerated matrix—much of which failed to show the normal basophilic staining reaction of this tissue—in which were set occasional cartilage cells. In some sparsely-cellular areas the matrix was eosinophilic and fibrotic. The normal regular columnar arrangement of cartilage cells was lacking, and the tissue was, on the whole, avascular. At some points on the periphery of the cartilage masses groups of cartilage cells were " hypertrophied," the basophilic staining reaction of the intercellular matrix was locally intensified, and there was some patchy vascularisation with irregular endochondral ossification. The remainder of the abnormal cartilage, however, was uncalcified. Both at the margin of the cartilage and in the nearby cortical bone the surfaces of bony trabeculae were devoid of any excess osteoid tissue, and the spaces between them were occupied by normal marrow (Fig. 14).

The main histological abnormality in the present case consists in the presence of irregular masses of abnormal cartilage in the metaphysial region. The appearance of this cartilage is similar to that present in the case described by Müller and Sissons (1951). No excess osteoid, which would indicate active rickets or osteomalacia, is present. No " osteitis fibrosa " is present, there being no histological evidence of the hyperparathyroidism that was suggested in the case described by Müller and Sissons.

Treatment and progress—Corrective osteotomy was done at the lower end of each femur, the material for histological examination being obtained during this procedure. Both osteotomies united normally, and the patient has subsequently been followed for two years without any new clinical development (Figs. 3, 4 and 5).

DISCUSSION

In the case described, an abnormality of ossification has produced interference with skeletal growth and development. Skeletal age is greatly retarded, and in many situations the normal replacement of proliferating cartilage by endochondral bone has failed to occur, masses of partly calcified cartilage accumulating and being responsible for the conspicuous radiological abnormalities in the metaphysial regions of the long bones. Secondary angulation at the site of the abnormal tissues has occurred in the bones of the lower limb, and in all situations the margin of the abnormal cartilage is marked by abnormally dense bone tissue. These changes, restricted as they are to the metaphyses, are remarkably similar to those

put on record by Jansen in 1934, and described by him as " metaphysial dysostosis," while the present case fails to show any abnormality of the shafts of the long bones which in Müller and Sissons's case was evidence for a diagnosis of renal osteodystrophy from both the radiological and pathological viewpoints. The changes in the present case are quite distinct from dysplasia epiphysialis punctata; although there is some similarity to the metaphysial lesions of dyschondroplasia, the changes in the bones of the hand—in particular—contrast with this condition in that no isolated cartilaginous masses are present in regions remote from the metaphyses.

Although the outline of the pituitary fossa could not be seen in radiographs of the skull in the present case, no clinical evidence of pituitary disorder was present and the radiological changes in long bones in no way resemble those found in pituitary dwarfism.

On the basis of the material presented, and of a comparison of it with the literature, the present authors regard " metaphysial dysostosis " as a distinct entity among the chondrodystrophies (in which group are included achondroplasia, dyschondroplasia, diaphysial aclasis, dysplasia epiphysialis multiplex, dysplasia epiphysialis punctata, Morquio-Brailsford disease, and gargoylism), and put forward the present case as an example of this condition. Metaphysial dysostosis appears to have certain affinities with dyschondroplasia and with achondroplasia, although ignorance of the pathogenesis of these conditions makes it impossible to assess the precise significance of such similarities, or of the exact criteria to be adopted in classification of atypical examples of these conditions.

SUMMARY

1. Details of clinical, radiological, biochemical and histological investigations of a case of metaphysial dysostosis are presented.

2. The patient was a boy of seven years, and showed widespread lesions (involving long bones of limbs, small bones of hands and feet, pelvis, clavicles, and ribs) characterised by retardation of growth and ossification with masses of partly calcified tissue in the metaphyses.

3. No radiological, clinical or histological evidence of renal osteodystrophy was found in the case described.

4. Metaphysial dysostosis is discussed in relation to other chondrodystrophies.

We wish to thank the Director of Medical Services, Singapore, for permission to publish the case. We are greatly indebted to Sir Thomas Fairbank for help in preparing the paper.

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TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD

Report of a Case

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Traumatic dislocation of the hip joint in a child is rare. It appears from a close study of the literature that the number of recorded cases in the last thirty-two years is eighty-eight. The youngest patient was aged eleven months and the oldest fourteen years. The average age was seven years.

Maffei (1922) found that, of 1,842 hip dislocations treated at the Rizzoli Institute of Bologna up to 1901, only three were in children. Choyce (1924), in a detailed survey of the published reports, including Maffei's study, collected fifty-eight cases and added one of his own. Clarke (1929) reported another case, and Glynn (1932) described the injury in patients

FIG. 1
Before reduction.

FIG. 2
Ten months after reduction.

aged three and seven years. Elmslie (1932) presented to the Royal Society of Medicine of London the case of a child who subsequently developed Perthes' disease. Elmslie had already made a similar contribution which was recorded by Choyce. Haines (1937) added another case in a child aged six years. Banks (1941), in a comprehensive survey of the literature of avascular necrosis of the femoral head, recorded four further cases of traumatic dislocation of the hip in children and added one of his own. These five children all developed Perthes'

disease and are included in a series of seven. The other two cases were previously described by Choyce. Paus (1951), in a clinical review of the late results of traumatic dislocation of the hip, mentioned a patient aged four years, and Thompson and Epstein (1951) in a similar communication recorded a series of seventeen children aged between six and fourteen years. Watson-Jones (1952) described one further case of dislocation of the hip in a child who subsequently developed Perthes' disease.

CASE REPORT

A boy aged one year and eleven months was brought to the hospital by his father. One hour before, while playing ball on the sand, the father tripped and fell on his son and partly buried him in the sand.

On examination, the child, normally developed for his years, was lying quietly on a couch, apparently in no pain. The left hip was held in flexion and adduction, and only on attempts to move the leg did the child protest. The right hip was normal.

Radiographs confirmed a posterior dislocation of the left hip (Fig. 1). The capital epiphysis was of normal size and shape, and in normal relation to the neck of the femur. The acetabulum and pelvis showed no abnormality.

Treatment—The dislocation was reduced under general anaesthesia. After flexion of the hip and rotation into a neutral position the head of the femur was easily lifted into the acetabulum. Fixed traction on a Thomas's splint was applied, and a radiograph showed full reduction. Light traction was maintained for six weeks and weight bearing was allowed after two months.

Progress—Ten months after the injury the child was walking normally and had a full range of powerful hip movements. The radiograph at this stage showed normal appearances (Fig. 2.)

DISCUSSION

Posterior dislocations of the hip joint are usually caused by a direct thrust in the long axis of the femur with the knee flexed and the hip adducted. A child is rarely exposed to violence of this nature, and this may explain the rarity of the condition in childhood.

In the case reported here, the child was in the " knee-elbow " position on the sand, probably with his knees together, and the father's knee landed heavily on his son's left buttock.

The interest in this unusual injury lies in the development of avascular necrosis of the upper femoral epiphysis. Traumatic dislocation of the hip is necessarily accompanied by rupture of the ligamentum teres and tearing of the joint capsule. There is a corresponding loss of blood supply in the region of the fovea and an impairment of the blood supply to the rest of the epiphysis. Banks (1941) described seven cases of avascular necrosis of the head of the femur after dislocation of the hip in children aged between four and twelve years. To this series can be added Elmslie's (1932) second case and the case described by Watson-Jones (1952).

These nine patients, who are included in the eighty-nine described above, appear to be the only examples of Perthes' disease complicating hip dislocations in childhood reported in the literature between 1922 and 1954. The incidence of Perthes' disease was therefore 10 per cent.

It is of interest that Nicoll (1952) in a follow-up of 144 adults who had sustained dislocations of the hip, recorded a 10 per cent incidence of avascular necrosis of the femoral head.

SUMMARY

1. The literature of dislocation of the hip in childhood from 1922 to 1954 is reviewed. A total of eighty-eight cases have been recorded.

2. A further case, in a child of one year and eleven months, is described.

3. Nine of the children whose cases have been recorded developed Perthes' disease of the hip after the dislocation, an incidence of 10 per cent. A similar incidence of avascular necrosis of the femoral head has been reported after dislocation of the hip in adults.

I wish to thank Mr P. R. Wright for permission to publish this case, and I am indebted to Mr R. Mason for the radiographic prints.

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FANCONI'S SYNDROME

Treatment by Massive Dosage of Calciferol and Two-stage Osteotomy

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From the Institute of Orthopaedics, Royal National Orthopaedic Hospital

Rickets caused by deficiency of vitamin D has almost disappeared in Great Britain, and for this reason attention is being focused more and more on the group of conditions which in the past has been loosely termed " resistant " and " renal " rickets.

Dent (1952) clarified the confusion that has surrounded the subject. He classified the etiology of the various rachitic and osteomalacic conditions into the following groups: 1) vitamin D and calcium lack; 2) the steatorrhoeas (coeliac, idiopathic, sprue); 3) bile salt deficiency: ? hepatic rickets; 4) renal glomerular defect (polycystic kidney and other gross renal defects); 5) renal tubular defect; ureterocolostomy.

In renal glomerular rickets, which is in fact the classical " renal rickets," both glomeruli and tubules are damaged or destroyed, leading to retention of urea, phosphates and other substances normally excreted in the urine.

In renal tubular rickets there is an inherited or acquired defect of tubular reabsorption. Various functions may be lost, depending on the site and extent of the defect. For clinical purposes this group can be sub-divided into six types, according to the nature of the tubular reabsorption defect: 1) phosphates only (low blood phosphorus); 2) phosphate+glucose (glycosuria); 3) phosphate+glucose+amino-acids (amino-aciduria, including cystinuria); 4) phosphate+glucose+amino-acids, with faulty urine acidification (low CO_2 combining power); 5) phosphate, with faulty urine acidification and high urinary calcium content; 6) phosphate, with faulty urine acidification, defective ammonia formation, and high urinary calcium content.

Many names have been given to sporadic cases of these conditions in the past. For example, types 1 and 2 have been described as resistant rickets, essential hypophosphataemic rickets, and Milkman's syndrome; types 3 and 4 have been termed Fanconi's syndrome, cystine rickets, renal rickets, and hypophosphataemic glycosuric rickets; and types 5 and 6 are sometimes called nephrocalcinosis with renal rickets and dwarfism, or Butler-Albright's syndrome. Types 1 to 4 tend to run in families. On the other hand types 5 and 6 are never hereditary, the cause being probably not genetic but environmental.

These six varieties of tubular defect may occur in either sex and at any age and may show spontaneous remissions and exacerbations. Radiographically they may be indistinguishable from each other and thus the differential diagnosis rests with the biochemist rather than the clinician. It is important to recognise these conditions because the results of treatment are often gratifying.

The case reported here accords with Fanconi's syndrome (type 3 or 4 of the classification), the signs of which are considered by Dent (1952) to be due to an inherited defect of reabsorption affecting primarily the proximal tubules of the kidney and involving amino-acids, sugar and phosphates. Like Fanconi (1936) he believes the disease to be inherited as a Mendelian recessive character. Severe cases show dwarfism, gross rickets, hypophosphataemia, amino-aciduria (including cystinuria), glycosuria, deposition of cystine in body tissues, and acidosis. The urinary output of glucose and amino-acids often varies from day to day.

CASE REPORT

A boy—an only child—was born at full term and the delivery was normal. He was breast-fed for nine months and had cod liver oil from the age of one month. There was no

FIG. 1
Before treatment. Note marked bowing of tibiae.

feeding difficulty, undue thirst or vomiting, but his weight was below normal. He was first seen at the Royal National Orthopaedic Hospital at the age of sixteen months with florid rickets (Figs. 1, 2, 3, 5). A striking feature of his appearance was that he was completely bald except for a small tuft of hair on the vertex. The kidneys were not palpable. The radiographs were typical of severe rickets (Figs. 2, 3, 5). The renal shadows were normal in size and position.

Investigations (at the age of eighteen months) showed the following results. *Urine*—There was an abnormal concentration of amino-acids (square chromatograms) (glycine, alanine, glutamine, lysine, and traces of cystine, threonine, valine and tyrosine). There was no glycosuria or albuminuria. *Blood*—serum calcium 9·2 milligrams per cent (within normal limits); alkaline phosphatase 73 units (normal 5–15); blood phosphorus 2·7 milligrams per cent (normal 5 for children); CO_2 combining power 39 vols. (normal 55–75); blood urea 29 milligrams per cent. *Faeces*—Normal fat analysis. *Slit-lamp examination*—No cystine deposit in the cornea.

Treatment—For nearly a year, until he was two and a half years old, the patient received 100,000 units of calciferol daily, the dosage having been stepped up from 20,000 units. Thereafter the dosage was increased to 500,000 units daily. Shohl's citric-acid-sodium-citrate solution was not given.

Progress—At the age of three years there was a trace of sugar in the urine and an excess of amino-acids, with the same chromatographic pattern as at the previous examination.

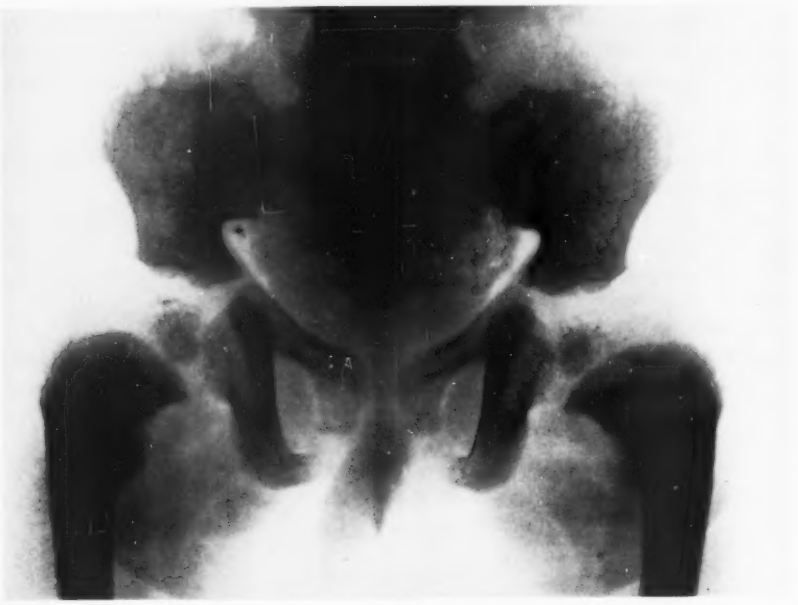

FIG. 2
Showing typical rachitic changes at the epiphyses.

According to Dent (1953) this constancy of pattern over a period of time is characteristic of Fanconi's syndrome.

Investigations, repeated at the age of three years, showed the following. *Blood*—serum calcium 9·2 milligrams per cent; alkaline phosphatase 57·6 units; blood phosphorus 4·0 milligrams per cent; CO_2 combining power 47·5 vols. Further examination at the age of four and a half revealed the following. *Urine*—This contained no amino-acids and no sugar.

FIG. 3

Figure 3—Left wrist before treatment.

FIG. 4

Figure 4—After twenty months' treatment with massive doses of calciferol.

FIG. 5

Figure 5—Right knee before treatment.

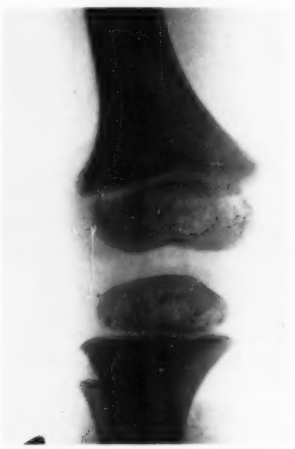

FIG. 6

Figure 6—After twenty months' treatment with massive doses of calciferol.

Blood—serum calcium 9·3 milligrams per cent (cf. 9·2 milligrams per cent); alkaline phosphatase 15·3 units (cf. 73 units); blood phosphorus 5·0 milligrams per cent (cf. 2·7 milligrams per cent); CO_2 combining power 53·3 vols. (cf. 39 vols.). At this time the radiographs showed healing (Figs. 4 and 6). This corresponded with the biochemical findings, namely a rise in blood phosphorus and CO_2 combining power and a fall in phosphatase. At the age of five and a half the biochemical findings were quite normal.

Correction of deformities—At the age of four and a half years, when there was good evidence of regression of the rachitic process, the tibial bowing was corrected by Moore's (1947) two-stage osteotomy, a technique well suited for the treatment of unusual types of deformity. Before the operation the calciferol was stopped for two weeks. The first stage of the osteotomy was performed on the right tibia. The fibula was first exposed and divided by an osteotome, and through a separate incision the summit of the curve of the tibia was exposed subperiosteally. A wedge of bone was removed leaving the posterior cortex intact; the wedge of bone was cut into small pieces and packed into the gap. No attempt was made to correct the deformity and the limb was enclosed in plaster. Two weeks later the plaster was removed and the deformity corrected by simple manipulation under anaesthetic. At the same time the first stage was performed on the left side and after a further two weeks the second stage.

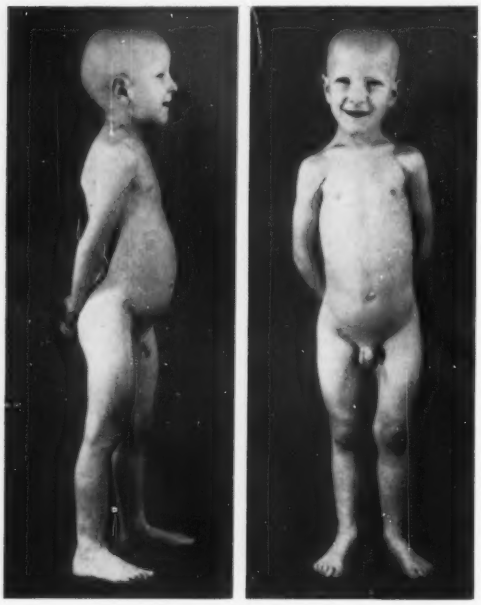

FIG. 7
Appearance after correction of tibial bowing.

A month after the last operation the plasters were removed (Fig. 7). The calciferol therapy was restarted ten weeks after it had been stopped. At first 200,000 units per day were given; this was gradually decreased to 100,000 units and at the time of writing this dose is being maintained.

The child's general condition is now excellent; he is alert and active and has a good appetite, and his weight is normal. Further examination of the urine reveals no amino-acids or glucose. There has been no recurrence of the tibial bowing.

SUMMARY

1. A case of Fanconi's syndrome, with evidence of renal tubular dysfunction, is reported.
2. Healing of the rachitic lesions followed massive doses of calciferol. There was simultaneous improvement in the biochemical state. This case is probably unique in that the amino-aciduria disappeared.
3. Two-stage osteotomies were undertaken for the correction of severe bowing of the tibiae.
4. No toxic symptoms have developed so far from the calciferol therapy.

I have pleasure in recording my thanks to Mr David Trevor for permission to publish this case and to Mr K. I. Nissen and Dr C. E. Dent for their kind and helpful criticism. I would like to thank Mr R. H. Whitley for the photographs.

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MULTIPLE PSEUDO-CYSTIC TUBERCULOSIS OF BONE

Report of a Case

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The term multiple pseudo-cystic tuberculosis of bone was suggested in 1952 by Komins to avoid existing confusion in the nomenclature of certain sarcoid lesions of bone and some forms of osseous tuberculosis. It applies to characteristic multiple cyst-like bone lesions seen in tuberculosis of children; it differentiates these lesions from those due to sarcoidosis which Jüngling (1920) had grouped under the term osteitis multiplex tuberculosa cystica; it also differentiates them from the multiple osseous tuberculous lesions seen in adults and to which the term disseminated bone tuberculosis has recently been applied by Alexander and Mansuy (1950). Komins suggested that the term osteitis multiplex tuberculosa cystica (or cystoides) be discarded but that a modification—osteitis multiplex cystoides sarcoidosa—be retained for the osseous lesions of sarcoidosis.

Multiple pseudo-cystic tuberculosis of bone is uncommon. Komins collected only thirty-one cases in a review of the English literature up to 1952; he emphasised, however, that some cases might have been lost in the confusion of terminology since Jüngling, who considered sarcoidosis as a form of tuberculosis, first used the term osteitis multiplex tuberculosa cystica in 1920 to describe a number of cases, many of which were sarcoid in nature.

Nineteen of Komins' thirty-one patients were two years of age or under, six were one year or under, and all were under fifteen. Eighteen out of twenty-one cases were in non-whites. The patient to be described in this report was of Indian extraction and was ten months old when he died. This case is of interest for three reasons: 1) the extensive involvement of the bones, particularly the skull; 2) the presence of a bone lesion at birth; and 3) the possible, though perhaps not likely, co-existence of syphilis.

CASE REPORT

The boy was born in Northern Manitoba of Indian parents. The father had been under treatment for syphilis for two years. The mother was not investigated until the patient was several months old; her blood Wassermann reaction was strongly positive seven months after the patient's birth. Her lungs showed no clinical or radiographic abnormality; a Mantoux test was positive. Three siblings were alive and well; one sibling died of undetermined causes at the age of four months. There was alleged to be no contact with tuberculosis, but such information is quite unreliable among many Indian populations.

The patient was normal at birth except for a swelling of the fifth right metacarpal. He was breast-fed almost exclusively and received no added vitamins. Progress was slow; he soon became weak, pale and irritable. At two and a half months he developed a chronic purulent nasal discharge, anorexia and occasional vomiting. At three and a half months bilateral cervical swellings appeared and he developed a cough; about three weeks later swellings appeared almost simultaneously on the forehead, at the proximal phalanx of the left index and ring fingers, below the right elbow anteriorly, and on the lateral aspect of the right upper arm. At five months the nasal discharge became bloody, and it was noted that the congenital swelling of the right fifth metacarpal, which previously had remained unchanged, also began to enlarge.

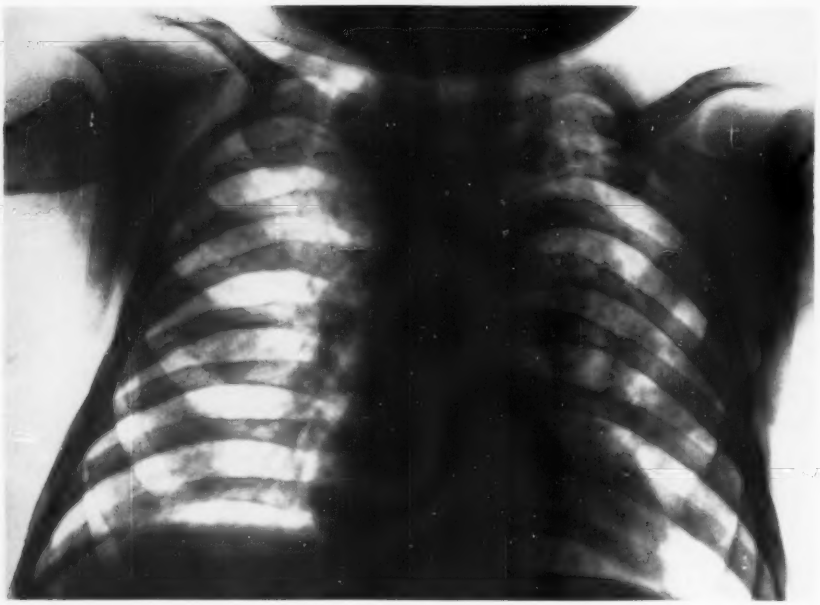

FIG. 1
Lung fields at age seven months, showing paratracheal lymphadenopathy and diffuse parenchymatous lesions.

FIG. 2
Skull at age eight months.

Clinical examination—On admission to St Boniface Hospital at the age of six and a half months he was a grossly malnourished, pale, irritable baby weighing only 12 pounds 13 ounces. He was too weak to sit up or even to support his head. There was intermittent sanguino-purulent nasal discharge but no local ulceration was evident. The liver and spleen were both palpable 4 and 2 centimetres below the costal margin respectively, smooth and somewhat firm. There was marked bilateral cervical lymphadenopathy. Several bony swellings were noted, particularly in the upper extremities and skull (Figs. 1 to 4). There was a prominent swelling almost in the centre of the forehead, 1·75 centimetres in diameter by 1 centimetre in height; it was soft and fluctuant, and was attached to the skull but not to the skin. Firm fusiform swellings were present in the fifth metacarpal of the right hand, and in the proximal phalanx of the index and fourth finger of the left hand. Other bony swellings were noted at the upper

FIG. 3

FIG. 4

Figure 3—Upper limbs at age eight months showing multiple pseudo-cystic lesions. Swelling of the fifth metacarpal was present at birth. Figure 4—Lower limbs at age seven months, showing early pseudo-cystic lesions in the tibia and fibula.

end of the ulna on each side and at the lower end of the right ulna. A mobile, slightly fluctuant mass, sized about 1·5 by 2·5 centimetres, was felt at the medial aspect of the right upper arm.

Investigations and additional findings—The Wassermann reaction was negative on two occasions but a single Kahn test was weakly positive (1 : 8 dilution). It was felt that congenital syphilis could not be excluded, particularly in view of the family history and some of the clinical findings. A three weeks' course of penicillin (total dose 2·3 million units) was therefore given. The child showed improvement in appetite, was much less irritable and the nasal discharge disappeared, but there was no appreciable gain in weight.

In the meantime a diagnosis of tuberculosis was made on the basis of a strongly positive Mantoux reaction (1 : 1,000), radiographs showing extensive bilateral pulmonary changes suggestive of tuberculosis, the presence of acid-fast bacilli morphologically identical with mycobacterium tuberculosis on smear and culture in pus obtained from the swelling on the forehead, and a biopsy of a cervical gland showing necrosis, Langhans' cells and a histology

compatible with a diagnosis of tuberculosis. Dihydro-streptomycin was started (total dose 14 grammes) and he was transferred to a sanatorium. Additional laboratory findings (at age seven months) were as follows: haemoglobin 53 per cent, red blood corpuscles 3·6 m., white blood corpuscles 28,950 (polymorphonuclears 59 per cent, lymphocytes 39 per cent, monocytes 2 per cent); platelets 750,000. Cerebro-spinal fluid normal except for 11 lymphocytes per cubic millimetre. Liver function tests: cephalin cholesterol flocculation ++++; thymol turbidity ++++; Takata-Ara ++++. No tubercle bacilli were grown from three stools.

Despite treatment, deterioration was progressive. He developed a chronic purulent discharge from the right ear which showed acid-fast bacilli on smear and culture. More swellings appeared in the skull and elsewhere; draining sinuses developed at some of the swellings. His temperature, which had ranged between 99 and 100 degrees Fahrenheit, rose to 102–103 degrees in the final month and he died at the age of ten months.

Post-mortem findings—The body was emaciated and weighed only 9 pounds. Draining sinuses were present, as already noted. Caseating lesions were found in the skull, in both ulnae, in the right radius, in the second, third and fifth right metacarpals, and the first, second and third left metacarpals, in the proximal phalanges of the left index and ring fingers, and in the right tibia and fibula. The visceral organs involved were the lungs, liver, spleen and kidneys. There was general lymphatic involvement, affecting the cervical, axillary, inguinal and hilar glands on both sides, and the mesenteric and retroperitoneal glands. A few small tuberculomata were found in the cerebral hemispheres, the cerebellum and the pons; one was immediately sub-meningeal but the lepto-meninges appeared intact grossly.

The skull lesions affected the frontal and parietal bones. They consisted of caseous areas in the cancellous bone, from half a centimetre to two centimetres in diameter, with erosion and expansion of the outer table and in some areas also the inner table. In one area the abscess had broken through the inner table to become confined by the dura, whereas in others it had broken through the outer table to involve the subcutaneous tissues and skin; in these areas the skin was fixed and no longer freely mobile over the swelling. Similar lesions were seen in the short and long tubular bones: they consisted of oval or round caseous lesions in the medullary cavity expanding the cortex, involving the periosteum and even breaking through this and the skin to form a draining sinus.

Microscopic examination—The typical histology of tuberculosis was seen in nearly all sections of the organs mentioned, with numerous Langhans' giant cells, necrosis, and acid-fast bacilli. No Langhans' cells were found in the brain, nor in the fifth right metacarpal and proximal phalanx of the fourth left finger, but acid-fast bacilli were abundant. Many lesions were of the miliary type. No histological evidence of syphilis was found (these findings were corroborated by the Armed Forces Institute of Pathology, Washington, D.C.). There was an occasional lesion in the liver which at first glance suggested a gumma but proved tuberculous. The middle ears and mastoids indicated moderate tuberculous involvement but the nasal cartilages, choroid of the eye, vertebral bodies and all other organs not already mentioned showed no lesion.

DISCUSSION

The extensive involvement of the short and long tubular bones and skull, and the pseudo-cystic nature of these lesions, are associated with the low resistance, in this case, of the American Indian to tuberculosis. Other coloured races show similar tendencies (Widmann, Ostrum and Miller 1939, Komins 1952). Straus (1933) emphasised that the lesions in the skull are seldom seen under one year of age; this is because such lesions start in cancellous bone and there is little cancellous bone in the skull in the first year of life.

The history of a lesion present at birth offers interesting speculation—though nothing more than speculation because the patient was not seen until several months later, when many other lesions had already appeared. Radiographs of this congenital lesion of the fifth right metacarpal at seven months were suggestive of tuberculosis, and histological examination

at necropsy three months later showed focal diaphysial necrosis, partial erosion and expansion of the cortex, and thickening of the periosteum; no Langhans' giant cells, but abundant acid-fast bacilli, were present. It is impossible to say whether the initial lesion was tuberculous or whether tuberculosis had been superimposed on another condition such as syphilis.

Did this infant have syphilis? Unfortunately necropsy does not help us much here. No spirochetes were seen in the tissues and no lesions suggestive of syphilis were found at necropsy, but it is possible that the course of penicillin administered three months before death may have eliminated all evidence of this disease. On the other hand, despite the positive family history, the positive Kahn reaction and the temporary improvement after anti-syphilitic treatment, it is still doubtful whether the child was syphilitic when first seen. Not all babies born of syphilitic mothers have the disease, and according to Kampmeier (1943) approximately 20 per cent escape. The Kahn reaction was only weakly positive and the Wassermann reaction was negative on two occasions; the temporary improvement after penicillin treatment may have been due to its effect on secondary invaders. It is not quite so easy to explain the disappearance of the haemorrhagic snuffles. Haemorrhagic snuffles has been described in tuberculosis in the absence of syphilis, but then penicillin would not be expected to be beneficial (Hughesdon 1946). Nevertheless the lesions seen on admission and at necropsy were all typically tuberculous, with marked evidence of caseation and suppuration, with many draining sinuses. According to Kampmeier suppuration with sinus formation is never seen in uncomplicated syphilis. The congenital lesion may have been due to syphilis; but it was an isolated lesion whereas it has frequently been stressed that the bony lesions of congenital syphilis are symmetrical.

SUMMARY

1. A case of multiple pseudo-cystic tuberculosis in an American Indian infant is described.
2. The extensive lesions in the skull of this infant are considered to be of particular interest.
3. The possible significance of a bony lesion present at birth is discussed.

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BRIDGING OF BONE DEFECTS IN THE FOREARM WITH ILIAC GRAFT COMBINED WITH INTRAMEDULLARY NAILING

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The successful treatment of an established pseudarthrosis in a forearm bone is always difficult, especially when the skin or soft tissues have been damaged by previous injury or infection. The usual technique is by the use of massive onlay grafts, as advised by Henderson (1938), Campbell (1939) and Speed (1942). In my experience this method, using a tibial graft, has had only moderate success in cases of pseudarthrosis.

When there is actual loss of bone and a gap needs to be bridged, the problem becomes even more complicated. The use of twin onlay grafts, as recommended by Boyd (1943), has definite advantages: the two cortical grafts screwed together give firm mechanical fixation, while bone chips, which fill the defect between the bones, supply an osteogenetic element. But the dual onlay graft has the disadvantage of considerably increasing the diameter of the bone, thus increasing the difficulties sometimes encountered in skin closure. Moreover granulation tissue may intrude into the bone at the site of screw fixation, leading to local absorption of the graft around the screw. Boyd stated that twin grafting in the forearm was advisable only when the bone defect was close to a joint. For defects in the shaft proper he advised full thickness fibular grafts, which fit the diameter of the bones and thus facilitate skin closure. There is less functional incapacity after the removal of a graft from the fibula than there is when the tibia is used. However, it is recognised that fibular grafts have poor osteogenetic power; their incorporation into the forearm bones is a prolonged and often uncertain process. Tavernier (1946) bridged bone defects in the forearm by tibial grafts secured together with catgut and a Kirschner wire through the medullary canal of the bone, with success in two cases. Palmer (1952) described experiments in dogs, and claimed successfully bridged bone defects in long bones with cylindrical homotransplants with cancellous chips, using a V-nail for fixation. With the same technique clinically he bridged a defect in a humerus.

Disappointed with my results after twin onlay grafting, I have developed a method of bridging bone defects by inserting a full-thickness iliac graft and ensuring rigidity by intramedullary nailing.

OPERATIVE TECHNIQUE

A preliminary stage, if necessary, consists of the excision of scars and securing adequate mobile skin covering by means of skin flaps.

At operation the bone defect is exposed, all scar tissue is excised, and sclerotic bone is resected. At the same time a second surgical team exposes an iliac crest up to and including the anterior superior iliac spine. The graft is cut and shaped, and a small canal is drilled through its length. After the recipient area has been prepared and the graft made ready, the intramedullary nail is introduced. The technique varies according to which bone is to be nailed. In the case of the radius the nail is entered at its distal end just medial to Lister's tubercle until its point can be seen emerging at the gap (Rocher 1945). The graft is placed in position and threaded on to the nail, which is then driven home into the proximal part of the radius (Fig. 1).

For the ulna the original nail for the forearm had to be modified. We removed the hook from one end, leaving a straight metallic rod pointed at both ends. The nail is driven from the gap into the proximal part of the ulna along its medullary cavity until it emerges through

the skin over the olecranon process. When only its point is visible in the gap the graft is brought into position and threaded on to the nail, which is then driven back into the distal end of the ulna (Fig. 2).

The mechanical fixation of the graft is tested by flexion and rotation of the forearm.

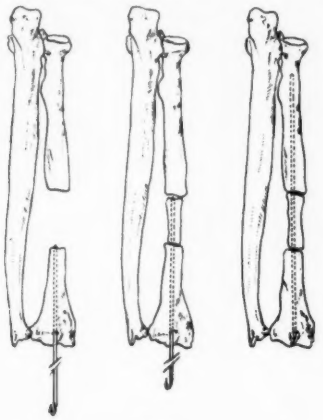

FIG. 1
Technique of grafting and nailing a defect of the radius. The nail enters at the lower end of the radius.

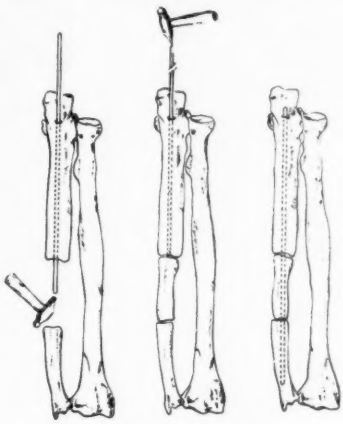

FIG. 2
Technique of grafting and nailing a defect of the ulna. The nail enters at the site of defect.

Cancellous iliac chips are packed around the ends of the graft. To broaden the contact between the bone ends and the graft and also to secure added fixation I have recently V-shaped the graft ends and the corresponding parts of the two bone ends, with great care to get a snug fit.

In three patients the distal end of the ulna was used as a graft, for it had to be resected to correct a severe radial deviation of the hand.

CLINICAL MATERIAL AND RESULTS

Thirteen patients have been operated upon, twelve men and one woman. In this series there were ten radial and four ulnar pseudarthroses. In one patient both bones had defects and both were grafted at one operation.

TABLE I
CLINICAL MATERIAL (THIRTEEN PATIENTS)

Bones affected	
Ulna alone	3
Radius alone	9
Both bones	1
Cause of injury	
Gunshot wound	12
Road accident	1
Complicating injuries	
Radial palsy	5
Muscle and tendon injury	13
Skin defects	3
Joint injury	1
Previous operations apart from primary excision	10

All the pseudarthroses followed open fractures, twelve of them from gunshot injuries. Apart from primary wound excision many of the patients had undergone further surgery before they came under my care; altogether there were ten previous unsuccessful operations. In five patients the radial nerve had been injured in the forearm (Table I).

FIG. 3

FIG. 4

FIG. 5

Case 1—Fracture of radius and ulna from road accident, originally compound. Figure 3—Before operation eleven months after injury. Note defect of radius. Figure 4—Distal end of ulna resected and used as graft. Figure 5—Three years after operation.

FIG. 6

FIG. 7

FIG. 8

Case 2—Fracture of radius caused by gunshot wound. Figure 6—Before operation, fourteen months after injury. Figure 7—After iliac grafting and medullary nailing (lower end of ulna also resected). Figure 8—One year later.

Fifteen bone-bridging operations were carried out on fourteen affected bones. On twelve occasions iliac bone was used, and on three the distal end of the ulna. The usual length of the graft was about five centimetres. The duration of fixation in plaster-of-Paris varied from three to nine months.

Of the twelve iliac grafts, nine were successful and three failed. In two cases non-union was explained by infection. In the other a fibrous union formed at the proximal end of the graft; the functional result was nevertheless good. Of the three cases in which the distal end of the ulna was used as a graft union occurred in two. Union failed to occur in one, but the bone was later successfully regrafted with ilium.

TABLE II

RESULTS

Iliac grafts	
Successful	9
Unsuccessful	3
(Sepsis 2, fibrous union 1)	
Ulnar grafts	
Successful	2
Unsuccessful	1
(Pseudarthrosis, regrafted with ilium)	

The period of observation varies from twenty to forty months after completion of treatment. The functional result was excellent in ten cases, good in one (that in which fibrous union occurred) and poor in two (the infected cases) (Table II).

Since the compilation of this report four further patients have been operated upon. But they have been excluded from the series because final assessment is not yet possible. One has developed an established pseudarthrosis at the proximal end of the ulnar graft; the other three grafts have united.

Illustrative radiographs are shown in Figures 3-8.

DISCUSSION

This method of grafting has several advantages. Because of its quadrangular form the ilium, with compact bone on three sides, has adequate strength. The spongiosa is rich in red bone marrow. It can be cut to the desired length and diameter and may be used even for bridging large gaps. The intramedullary nailing gives firm fixation without any weakening of the graft. The pliability of the Rocher nail (1945) makes it very suitable for this purpose. The extraction of the nail is a minor procedure not requiring exposure of the grafted area.

The incorporation of the graft into both recipient areas progresses without any demonstrable change in its appearance, a very remarkable fact. Because of its small osteogenetic properties it is considered that the distal end of the ulna should be abandoned as grafting material.

In this series of fifteen operations two grafts were lost from infection. Infection after grafting is a catastrophe, but since all our operations have been performed for compound fractures that were initially infected, the two failures should not count too heavily against the results.

SUMMARY

1. A technique for bridging bone defects in the forearm with massive iliac graft and medullary nailing is described.

2. The results of fifteen operations are reviewed.

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FATIGUE FRACTURES OF THE LOWER TIBIA

A Report of Five Cases

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Fatigue fractures of the upper third of the tibia are not rare, but we have found reports of only three cases in the lower third. The following cases, in which the lower tibia was affected, are therefore of interest.

CASE REPORTS

Case 1—A doctor, aged forty-five, attended the Royal Free Hospital complaining of pain in the left ankle for six weeks. There was no history of injury or unusual activity. On examination there was swelling and tenderness on the inner side of the lower third of the left leg. Ankle movements were full. Radiographs showed a transverse band of callus with a hair-line fracture running from the medial aspect half way across the shaft, one and a half inches above the tip of the medial malleolus (Fig. 1).

The patient was treated in a walking plaster for four weeks, after which all pain, tenderness and swelling had disappeared. Radiographs two months later showed that the fracture was uniting (Fig. 2).

A year later he attended again with similar symptoms in the right ankle; the pain had begun spontaneously, without injury or unusual activity. There was tenderness and swelling over the

FIG. 1

FIG. 2

Case 1. Figure 1—Initial radiograph of left tibia. Figure 2—Two months later.

lower end of the right leg on the inner side. Radiographs showed no abnormality. Further radiographs a week later, however, revealed a fracture of the cortex of the tibia (Fig. 3). A walking plaster was applied and he made an uneventful recovery in six weeks (Fig. 4).

Radiographs revealed no other skeletal abnormality apart from an old injury of the left shoulder.

Investigations—Examination of the blood gave the following results: Serum total protein 6·9 per cent; phosphorus 2·79 milligrams per 100 millilitres; total protein 7·15 grammes per 100 millilitres; albumen-globulin ratio 2·07; erythrocyte sedimentation rate 7 millimetres in one hour; gamma

globulin 0·81 grammes per 100 millilitres. The stools showed no abnormality. Thorough investigation failed to reveal any underlying disease such as occurs with " pseudo-fractures " in Milkman's syndrome.

FIG. 3

FIG. 4

Case 1. Figure 3—Right tibia, two weeks after onset of symptoms. Figure 4—Six weeks later.

Case 2—A woman aged sixty-nine had been confined to bed by her doctor because of a painful right ankle which had been ascribed to arthritis. She spent four weeks in bed and during this time the pain gradually disappeared. The onset of the pain had been gradual and there had been no injury. On the day she was allowed up she tripped on the stairs and the pain recurred. She attended hospital the same day. On examination her general health was good. There was tenderness and pitting oedema over the medial malleolus and distal four inches of the tibial shaft, without increased heat or redness. The movements of the ankle and subtalar joints were full, but painful at the extremes.

Radiographs showed a slightly oblique irregular zone of callus one and a half inches above the tip of the medial malleolus, extending beyond the cortex postero-medially. In the centre

FIG. 5

Case 2—Fatigue fracture with prominent callus.

there was a narrow zone of osteoporosis (Fig. 5). Further radiographs taken five months later showed residual buttressing on the postero-medial aspect.

Investigations—The Wassermann and Kahn tests were negative. Comparison of a radiograph of the hand and of a control did not reveal any abnormality of bone texture or density.

Case 3—A woman aged fifty-nine had been treated with salicylates by her doctor for a painful left ankle for six weeks before she attended hospital. The complaint had been diagnosed as " rheumatism " and she was told that she had been too active. On examination the foot was

FIG. 6

FIG. 7

Case 3. Figure 6—Early radiograph showing fatigue fracture. Figure 7—Condition two months later.

clinically normal except for pain on full inversion of the subtalar joint. But there was some tenderness and swelling over the distal four inches of the tibial shaft. Radiographs showed a transverse fracture one and a half inches above the tip of the medial malleolus (Fig. 6). Further radiographs two months later showed obliteration of the fine fracture line and abundant callus (Fig. 7). Two years later buttressing was still present.

Investigations—The Wassermann test was negative. Blood examination showed: serum calcium 11 milligrams per 100 millilitres; serum phosphorus (inorganic) 2·7 milligrams per 100 millilitres; alkaline phosphatase 6 units; acid phosphatase 1·4 King-Armstrong units. The bone texture was found to be normal when the radiographs of the hand and a control were compared.

FIG. 8

FIG. 9

Case 4. Figure 8—Early radiograph, about two weeks after onset of symptoms. Figure 9—Condition six weeks later.

An interesting sequel was the development of calcinosis in the tip of the right index finger two and a half years later.

Case 4—A man aged sixty-two complained of pain in the right lower leg, which was swollen after walking, for five weeks. He was accustomed to walking several miles a day but had not

recently increased his activities. There was no relevant history of illness. On examination he appeared to be in good general health. There was pitting oedema in the ankle region, with tenderness over the lower end of the tibia. Ankle movements were slightly limited. Radiographs showed an incomplete transverse fracture two and a half inches above the tip of the malleolus (Fig. 8). Six weeks later the fracture had united with abundant callus (Fig. 9).

Case 5— A woman aged sixty-three years attended hospital complaining of pain and swelling in the left ankle for five weeks. There was no history of injury or unusual activity. On examination there were pitting oedema and tenderness over the medial malleolus extending upwards for two inches. Movements of the ankle and subtalar joints were normal. Radiographs showed a transverse fracture one and three-quarters inches above the tip of the medial malleolus (Fig. 10).

Investigations—The Wassermann test was negative. The plasma acid phosphatase was 0·8 King-Armstrong units, and the plasma alkaline phosphatase 7·8 units.

FIG. 10

FIG. 11

Case 5—Bilateral fatigue fractures. Figure 10—Left tibia three weeks after onset. Figure 11—Five years later. Similar fracture of right tibia.

After four weeks in a viscopaste bandage the patient had no pain or swelling and a further radiograph one month later showed that the fracture was healing.

Later history—Five years later she attended again with the complaint of pain and swelling " near her right ankle " for two weeks. There was pitting oedema of the ankle as far as the middle of the shaft of the tibia and there was marked tenderness over the tibia two inches above the tip of the medial malleolus. Movements of the ankle joint were full. Radiographs showed an irregular transverse hair-line fracture two and a half inches above the tip of the medial malleolus (Fig. 11).

Investigations—A radiograph of her hand and of a control showed the texture of the bone to be normal. The plasma alkaline phosphatase was 12 units, and the serum phosphorus (inorganic) 3·2 milligrams per cent.

DISCUSSION

Fatigue fractures of the tibia are usually associated with unaccustomed exercise in young people (Ollonqvist 1937). The form of activity preceding the fracture has differed according to the environment of the patient. The largest groups have been reported from Finland (Ollonqvist 1937) and Germany (Brandt 1941) and consist exclusively of soldiers. In Great Britain and America relatively few cases have been described and these are mainly in children and athletes (Kelly and Murphy 1951), although during the second world war cases were described in Servicemen (Mann 1945, Wolfe and Robertson 1945). The commonest site for fatigue fractures of the tibia is in the upper third where over sixty have been described;

only three have been recorded in the lower third. We have not found any fatigue fractures of the tibia recorded in the middle-aged.

The five patients in this series were between forty-five and sixty-nine years of age. All had led active lives but in none was there a history of unusual activity or illness preceding the fracture. All described the pain as in the ankle or just above it and of gradual onset.

A transverse hair-line fracture developed in each, later being surrounded by abundant callus, at a point between one and a half and two and a half inches above the tip of the medial malleolus. In no case was there any other demonstrable evidence of clinical or radiological abnormality.

In reviewing fatigue fractures of the fibula, Burrows (1948) described two groups: fractures in young male runners and skaters; and fractures in women of middle age or over who have much to do on their feet.

Our cases in the lower third of the tibia have much in common with his second group. However, two of our cases were men and the preceding activity was not unduly marked.

Burrows (1948) demonstrated that fatigue fracture in the lower end of the fibula, in the middle-aged group, occurred at the site where the ratio of cancellous to cortical bone was greatest. Our experience parallels this in the tibia, the critical point being one and a half to two and a half inches above the tip of the medial malleolus. This is at the uppermost limit of the inferior tibio-fibular interosseous ligament.

SUMMARY AND CONCLUSIONS

1. Five patients with seven fatigue fractures of the lower third of the tibia are described; two had bilateral fractures. There is a striking similarity in the site and appearance of these fractures.

2. All occurred in middle-aged or elderly people without a history of unusual activity or illness.

3. The fractures are so nearly identical as to constitute an entity which, as far as we are aware, has not been described before.

We have much pleasure in recording our thanks to Mr Charles Gray and Mr L. W. Plewes for allowing us to publish Cases 1, 3 and 5 and for their kind and helpful criticism. We would also like to thank Mr J. S. Sheppard and Mr L. G. Holton for the radiographic prints.

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TRAUMATIC SPASM OF THE POSTERIOR TIBIAL ARTERY AT THE ANKLE

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Traumatic arterial spasm as a complication of fractures, gunshot wounds and crush injuries has been well recognised during the last fifteen years. It has been uncommon, however, to find traumatic arterial spasm distally in the hand or foot and the case now reported is of interest from this point of view. Cohen in a large series of cases was able to recall only one similar example.

CASE REPORT

A farm stockman aged nineteen was rounding a corner on his motor cycle when he found a broken-down car across the road. He brushed against the car as he passed it and the inner side of his left ankle was crushed against the chain case of his motor cycle.

FIG. 1
Appearance of foot at time of admission.

He was admitted to hospital one hour after the accident. His general condition was good. He stated that he had walked on the foot after the accident and although it felt rather numb and dead he did not notice any other untoward symptoms.

Examination of the foot revealed a ragged open wound with loss of skin over the inner side of the ankle; one end of a severed tendon was projecting from the wound. There was a striking colour change in the medial three toes; they were blue, cold, and insensitive to pin prick. There was a fairly sharp line of colour change and sensitivity at about the level of the metatarsal heads (Fig. 1).

Operation—Under general anaesthesia the foot was thoroughly cleaned and the wound inspected. There was a fracture of the medial malleolus and the tibialis posterior tendon was found severed at the same level. The neurovascular bundle was carefully exposed; the two veins were normal, but the posterior tibial artery narrowed suddenly to a mere thread precisely at the level of the fracture. The posterior tibial nerve was intact (Fig. 2). The

artery was followed to the point at which it disappeared beneath the abductor hallucis; it was in spasm as far as it could be traced. It was carefully dissected out and stripped of its coverings, with a consequent slight increase in calibre, but there was no return of pulsation. One per cent procaine was injected around the vessel. This produced a slight further improvement in calibre, but still there was no pulsation. Procaine was therefore injected intra-arterially, and the injection was followed immediately by dilation of the vessel and pulsation throughout its visible length. The severed tendon was repaired. The wound was

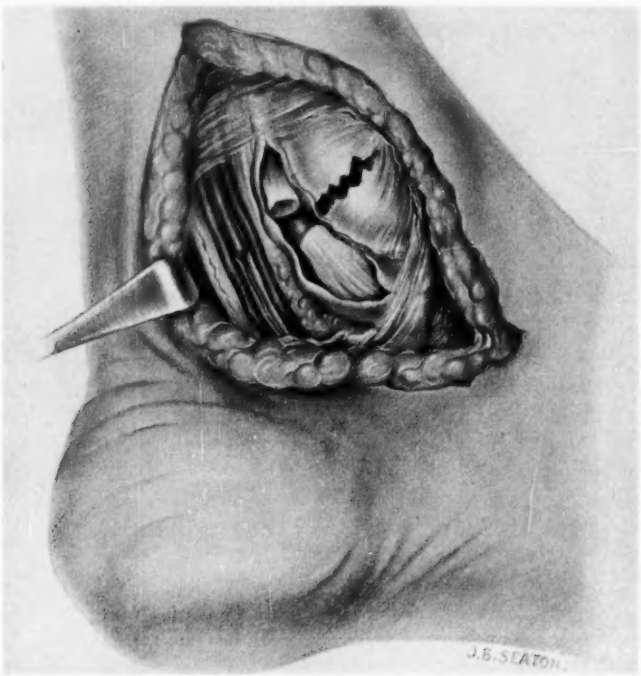

FIG. 2
Findings at operation. The posterior tibial artery was in spasm.

dressed but left open, and a padded plaster was applied with the foot inverted. The plaster was split immediately after its application. As the plaster was being trimmed (about fifteen minutes after the intra-arterial injection) there was a sudden pink flush in the area previously discoloured.

Progress—There was severe swelling and slight impairment of sensation in the toes for several days after the operation, but the circulation was never in question. The wound was later grafted successfully with split skin. Six months after the accident the patient has an almost normal foot and is back at work.

My thanks are due to Miss Janet Seaton for the beautifully executed drawings.

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BIOPHYSICAL STUDIES OF THE BONE TISSUE IN OSTEOGENESIS IMPERFECTA*

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Osteogenesis imperfecta is a rare hereditary or sporadically occurring disease, primarily affecting bone but sometimes also involving other mesenchymal tissues. The bones are abnormally fragile, and multiple spontaneous fractures of long bones often occur. The normal compact corticalis is absent and a loosely arranged immature spongy bone is formed. The disease may develop *in utero* and can sometimes be recognised immediately after birth (osteogenesis imperfecta congenita), or become clinically apparent in childhood or adolescence (osteogenesis tarda).

The etiology is unknown. The osteoblasts seem to be retarded in their function because of lack of differentiation: they are not capable of forming normal compact bone (Wilton 1932). Several investigations have been carried out to determine whether there is an abnormality in the metabolism of calcification. The blood chemistry, however, seems to be within normal limits at all ages (Albright and Reifenstein 1948).

In order to obtain further information about the disease we have examined bone specimens from four cases by biophysical methods. The distribution and amount of bone salts in different structures have been studied with microradiography. The nature and the orientation of the mineral salts have been studied with x-ray diffraction. The distribution and orientation of collagen has been studied in decalcified sections with polarised light. Conventional morphological methods have also been used.

MATERIAL

Case 1—Boy, eight years of age. The disease was discovered at the age of two years. A biopsy specimen was taken from the shaft of the tibia.

Case 2—Girl, three years of age at death. The disease was diagnosed immediately after birth. The case history and morphological necropsy findings were described in detail by Wilton (1932). Specimens from different bones have been investigated.

Case 3—Boy, five months of age at death. Osteogenesis imperfecta was diagnosed immediately after birth. Necropsy specimens taken from different bones.

Case 4—Girl, seven years of age at death. Birth weight 2·3 kilograms. No malformation known in the family. A mesenchymal disease of the osteogenesis imperfecta type was diagnosed immediately after birth. Radiographs at the age of six weeks revealed shortening and clumsy broadening of the femur, tibia and humerus, and, at several points, cyst-like thinning of the bone with several fractures (Fig. 1). The skull was rather large, but a slight suspicion that the girl was hydrocephalic was dispelled by radiography in 1948 and 1949. The girl suffered several fractures of the tibia and femur from very slight violence. She developed severe deformities of the femur and tibia with antero-lateral curvatures. When she was seven years old it was decided to correct the deformities of the lower limbs by osteotomies on both femora. Radiographs of the long bones now revealed normal structure of the bone (Fig. 2). The girl died during the osteotomy and an additional cause of death might have been a

* This is the fourth of a series of papers entitled "Biophysical studies on bone tissue." The three earlier papers were by Engfeldt, Engström, Helander, Wilton and Zetterström (1952); Engfeldt (1953); and Engfeldt, Engström and Zetterström (1954).

pronounced platybasia that had developed during the course of the disease. Apart from this finding the necropsy revealed a small girl for her age (height 83 centimetres, weight 17 kilograms) with a short neck and trunk. The sclerae were blue. The internal organs did not show anything of special interest. The lower extremities were rotated outwards. The femora were abnormally short, with pronounced lateral curvature. The tibiae showed anterior curvature. The compact bone was fragile and in the diaphysis of the femora the marrow cavities were partly occluded. A slight thoracic rosary was also observed. Specimens from different internal organs and from bone tissue from the femur, tibia, rib and skull were investigated.

FIG. 1

FIG. 2

Case 4—Radiographs of lower limbs. Figure 1—At the age of thirteen months. Figure 2—At the age of seven years. There is marked deformity of the long bones, with reduced calcification especially in the spongy part of the bone. The metaphyses are grossly intact.

METHODS. General technique—Since the bones were very fragile some of the bone specimens were embedded in methylmethacrylate before further treatment. Transverse and longitudinal sections were ground on glass plates to a thickness of 60–80μ. Decalcification of the sections was done in 5 per cent formic acid.

Microradiography—The technique was essentially the same as that described by Engström and Wegstedt (1951). A Machlett AEG 50 tube with 1 millimetre Be-window served as the source of radiation. The tube was run at 8 kilovolts, giving x-rays with a short wavelength limit of 1·5 Å., and a highest intensity at about 3 Å.—that is, where calcium has its greatest absorption. For large specimens, microradiographs were registered with a North American Philips diffraction unit run at 35 kilovolts and with a focus-to-emulsion distance of 25 centimetres. The microradiographs were taken on Lippman emulsion or Eastman Kodak spectroscopic plate 649. The resolving power of these emulsions is about 1000 lines per millimetre. The microradiographs were enlarged by photomicrography with Kodak 0250 plates.

Polarised light—The ground decalcified sections were mounted in 5 per cent sodium sulphate and photographed in polarised light (crossed Nichol prisms).

X-ray diffraction—A Siemen Crystalloflex II diffraction unit with copper Kα-radiation filtered in Ni served as radiation source. A Hilger powder camera with 190 millimetre diameter was used to record the diffractograms.

RESULTS

Histological examination—Bone tissue from osteogenesis imperfecta revealed similar findings in our four cases. Thus, in the long bones, instead of normal compact bone a coarse fibrillar bone of immature type was found. The epiphysial plate was irregular and sometimes rather broad, and the columnar proliferating cartilage was abnormal. For a detailed description of the histological findings in osteogenesis imperfecta the reader is referred to the work of Wilton (1932).

Microradiography—Figure 3 is an enlarged microradiograph of a transverse section of a normal femoral diaphysis from a child who was seven years of age at death and showed no signs of bone disease. The microradiographic picture of normal bone has been described in detail by Amprino and Engström (1952). Different parts of compact bone have a different absorption of x-rays, indicating that the bone is not uniformly calcified. Different Haversian systems (osteones) contain a varying amount of mineral salts, systems with the least being the youngest. When the Haversian systems grow older their mineral content progressively increases. The old bone (fragments of old Haversian systems and interstitial lamellae) surrounding the osteones has the highest content of calcium salts. In the normal compact bone a continuous rebuilding is going on. Resorption cavities are formed, involving old bone as well as Haversian systems at different stages of mineralisation. Later, the cavities formed are again filled with bone substance—that is, new osteones are formed.

The microradiographs from all four cases studied showed the same type of deviation from normal bone tissue. In Case 1 transverse sections from the compact bone of the tibia showed a trabecular coarse-fibred bone tissue of immature type. The degree of mineralisation was the same throughout the sections and no Haversian systems were found. Similar preparations from the diaphysis of different long bones from Cases 2 and 3 revealed the same abnormalities as in Case 1. No normal compact bone could be demonstrated and the marrow cavity was partly replaced by trabecular bone tissue. Several fractures of varying age were found. Figure 4 is an enlargement of a microradiograph of a cross-section from the femur of Case 4. No Haversian systems can be seen in this section and there are numerous large resorption cavities. The normal pattern of the tissue is completely disturbed. Figure 6 is a highly magnified microradiograph from the same case showing the detailed structure of the spongy bone trabeculae. The osteocytes appear as round or spindle-shaped areas transparent to x-rays. In osteogenesis imperfecta these areas are bigger and more numerous than in normal bone of the same stage of development. Only a few poorly organised Haversian systems could be seen in some sections. As far as can be judged by this method the mineral content is, in most instances, the same in all parts of the bone, the varying degrees of mineralisation of different parts of the skeleton characteristic for normal compact bone being absent. However, in sections from Case 4, some normal Haversian systems were found in the otherwise abnormal bone of the compacta, indicating that a partial normal rebuilding of bone tissue was taking place. In this case we also found numerous large resorption cavities in the abnormal compacta. As can be seen from Figure 4, these cavities were lined in some places with newly formed bone tissue, as indicated by its low degree of mineralisation. Cementing lines separating bone tissue formed at different times could also be detected in these specimens.

Polarised light—Figure 8 shows the regular arrangement of the collagen fibres in a cross-section from normal compact bone. Figure 7 is a photomicrograph in polarised light of the same decalcified section shown in the microradiograph in Figure 5. Instead of concentric

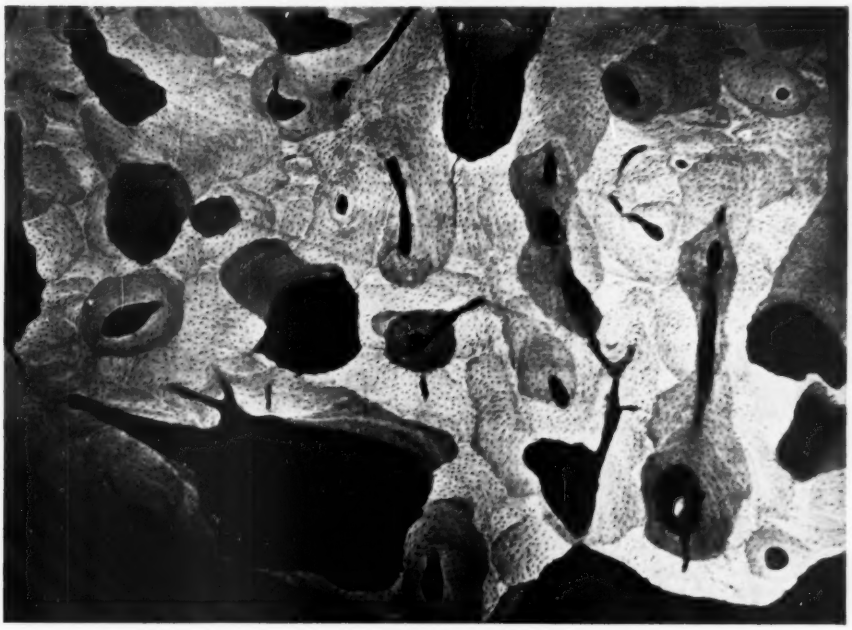

FIG. 3

Microradiograph from ground cross-section of the diaphysis of normal femur from a seven years old child. (×50.)

FIG. 4

Microradiograph from ground cross-section of the diaphysis of femur from Case 4. (×50.)

FIG. 5
Case 4—Decalcified ground section, transmitted light. (×110.)

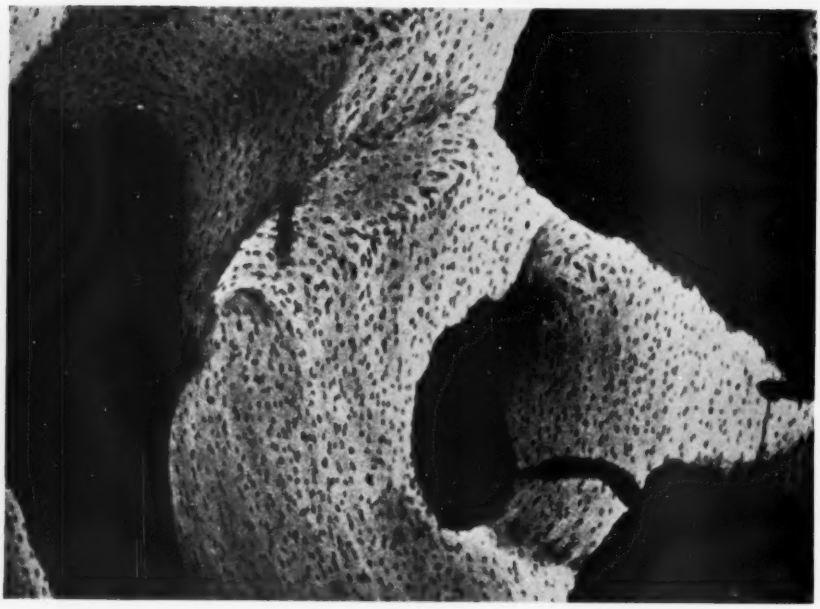

FIG. 6
Case 4—Microradiograph of the same section before decalcification.

FIG. 7
Case 4—The same decalcified section in polarised light.

FIG. 8
Decalcified cross-section from normal compact bone of femur, polarised light. (×110.)

layers of collagen fibres there is a quite irregular arrangement. In some areas there are short broad bundles going in different directions; in others there is no evidence of orientation whatever. A comparison with the microradiograph shows that the ratio between collagen and mineral salts differs widely in different parts of the bone trabeculae.

X-ray diffraction—The x-ray diffraction pattern of bone from osteogenesis imperfecta was found to be identical with that of normal bone. The diffraction lines are rather diffuse, indicating relatively small particles. The diffraction pattern improved on heating in the same way as did the patterns from normal bone. After heating, the pattern still proved to be of the hydroxyapatite type. In longitudinal section of the diseased bone some orientation of the mineral salts could be observed. In normal bone the axis of the apatite crystallites is parallel with the fibre axis of the collagen and so also is the c-axis in the hydroxyapatite unit cell.

DISCUSSION

This investigation indicates that in osteogenesis imperfecta the compact bone has a quite abnormal distribution of mineral salts and arrangement of organic fibres. The type of mineral distribution and the arrangement of collagen have some features in commom with the newly formed spongy bone of the growth zone. The immature fibrillar bone normally seen in the foetus and the newborn infant resembles in several ways the tissue found in osteogenesis imperfecta. Normally this primary bone tissue is rapidly replaced by secondary bone after birth, but in osteogenesis imperfecta this secondary bone tissue is not found (Fig. 4).

The normal rebuilding of bone tissue and its transformation into compact bone depends on the activity of osteoblasts and osteoclasts. This rebuilding is almost or completely absent in osteogenesis imperfecta, indicating a disturbed function of the osteoblasts and osteoclasts. However, patients who survive longer show that remodelling processes can occur, and these patients grow in size, although often slowly. The rebuilding process which is then seen is of an abnormal type. Resorption of bone tissue occurs, but the new bone formed does not develop into distinct Haversian systems. Instead, an immature lamellar type of bone tissue develops and shows differences in mineralisation of the same kind as are found in normal bone.

The growth in length of the long bones, which is primarily dependent on the growth of epiphysial cartilage, is sometimes stated (Weinmann and Sicher 1947) to be normal in osteogenesis imperfecta. Our findings are not in agreement with this. The histological examination showed an irregular, somewhat broadened, epiphysial plate and proliferation of the cartilage without the typical columnar arrangement. The microradiographs of the epiphysial zone can reveal an irregular zone of calcification which is quite abnormal in appearance. Cases have been described in which the abnormal bone tissue reverts to normal. Different findings in the epiphysial zones might thus perhaps be explained as depending on differences in the stage of development of the disease.

The skeleton in osteogenesis imperfecta is very fragile. Our results seem to indicate that this fragility of the skeleton is dependent not only upon the absence of normal compact bone but on the irregular arrangement of the organic matrix.

It is commonly supposed that the disease is caused by an abnormality of bone formation. The absence or deficiency of some factor responsible for the development of the calcified metaphysial tissue into functionally normal bone may be concerned. In ectopic bone tissue produced by injecting ethyl alcohol intramuscularly in rabbits the distribution of the mineral salts and the arrangement of the collagen fibres resembles that found in osteogenesis imperfecta (Engfeldt and Engström, unpublished), the bone tissue formed in both instances being of an immature type. In ectopic bone there is certainly lack of organ differentiation, and in osteogenesis imperfecta the disturbed development of bone tissue conditioned by a genetic abnormality of the mesenchymal cells also appears to manifest itself in a poor organ differentiation.

SUMMARY

Results are given of a study of four cases of osteogenesis imperfecta using biophysical methods comprising microradiography, microscopy using polarised light, and x-ray diffraction. Rebuilding of bone tissue was infrequent in the material studied and has been shown to occur in an abnormal manner. The mineralisation of the bone is more uniform than is found in normal bone. The collagen has an abnormal organisation and is sparse. The ultrastructure of bone salts and their orientation are as in normal bone.

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ROBERT BLAKEWAY WADE

1874-1954

The death of Sir Robert Wade of Sydney, Australia, marks the end of a long and distinguished career of service to the community.

He was widely known for his lifelong association with the Royal Alexandra Hospital for Children, where his invaluable efforts and gifted administrative capacity contributed largely to the establishment of this hospital in 1906 from its small beginning as the Sydney Hospital for Sick Children. Associated with the hospital continuously since 1897, he became an Honorary Surgeon in 1912. By this time his reputation had become established as a paediatric surgeon. His interest in orthopaedic surgery was now rapidly developing and he availed himself of every opportunity to study methods at overseas orthopaedic centres. The result was that he originated techniques which later became standard practice.

He was Director of Orthopaedics to the Army during the first world war and occupied a similar position at Randwick Military Hospital during the following years. It was common knowledge that the results obtained by him in his work at this hospital were outstanding. It is also remembered that he was instrumental in importing and installing the first short wave machine into New South Wales.

Robert Wade retained an active interest in orthopaedic surgery up to the time of his retirement in 1932 from the honorary staff at the Royal Alexandra Hospital for Children. His appointment as president of the Board of this hospital, which followed immediately, was therefore not unexpected and he added further lustre to his name by his unexcelled judgment in its guidance and direction.

He still retained a youthful mind and his vast capacity for work was not dimmed by advancing years. He was a foundation member of the Royal Australasian College of Surgeons and was the president of the College from 1935 to 1937. In that year also he became an Honorary Fellow of the Royal College of Surgeons of England. He was elected the first chairman of the body now known as the Consultative Council of the Physically Handicapped; this committee was formed in 1937 with the object of advising the Minister of Health on all matters relating to poliomyelitis and to provide adequate treatment, after-care and rehabilitation for those who suffered from this disease. In 1938 he was created a Knight Bachelor, an honour that was a tribute in recognition of his great services to the community and especially to child welfare.

Robert Wade practised his profession during a period when it was not unknown for a doctor to engage in more than one speciality. It is noteworthy that he achieved fame in the wide field that he chose and at the same time was able to give the various bodies over which he presided the benefit of his unerring judgment and unrivalled administrative talents.

K. S.

WINIFRED DUCHESS OF PORTLAND, D.B.E.

1864-1954

It is well that we should remember, particularly in these days of a National Health Service, how much orthopaedic surgery in Great Britain owes to many who have not been members of our profession.

Of these, three names are outstanding—Dame Agnes Hunt, Dame Georgiana Buller and Winifred Duchess of Portland. It is not too much to say that but for their enthusiasm and energy three of the major orthopaedic centres, the Agnes Hunt and Robert Jones Orthopaedic Hospital, Oswestry, the Princess Elizabeth Hospital, Exeter, and the Harlow Wood Orthopaedic Hospital, Nottingham, could not have been developed as they have.

Each of these ladies was very appropriately made an honorary Fellow of the British Orthopaedic Association. And now the last, Winifred Duchess of Portland, at the age of ninety, has died. She was a good friend of orthopaedics and many members of the British Orthopaedic Association visited her home, Welbeck Abbey, when meetings were held in Nottingham. Her life was one of great and varied interests. She mixed on equal terms and was respected by all sections of the community. She was interested in most forms of human activity and especially in the welfare of people and in the care of animals.

All this sprang from a kindly heart. She could not bear to hear of suffering, particularly if it could be prevented, and her great desire was at once to take some action to relieve it.

When, in 1923, I came to Nottingham to develop a scheme for the prevention, treatment and training of cripples, I found in Winifred Duchess of Portland a staunch ally. She saw that one of the first steps must be to create local interest and with her influence public meetings were held in Nottingham and the surrounding towns. So successful were they that in 1929 on land given by her husband, the Duke of Portland, the building of Harlow Wood Orthopaedic Hospital was completed and opened by the late King George VI and the Queen Mother, then the Duke and Duchess of York.

After the second world war the Duchess saw the possibility and the necessity for the establishment of a training college for disabled men who needed help to make themselves self supporting. She threw into this project the same interest and enthusiasm as she had into the establishment of Harlow Wood; it was equally successful and the Portland Training College was opened in 1950.

The Duchess had the true Elizabethan pioneering spirit. She was undaunted by difficulties, undisturbed by obstruction and undeterred by rules, unless she was convinced they were helpful. She was concerned, not with institutions but with the work they did. She took the keenest interest in the well-being and progress of patients and trainees; she was interested in their surgical condition, in their homes and in everything which would help to make them happy and useful citizens. Many were the homes she visited because she thought there was some distress she could alleviate. She was particularly anxious to help the miners who were injured in pit accidents.

In spite of her own increasing weakness and disabilities, she kept up her enthusiasm to the end. Almost her last act was to cause to be erected, round the roof of the Portland Training College, the words " Except the Lord Build the House their Labour is but lost that build it." That was the real key to an understanding of a life during which so much was accomplished. Countless people, especially in Nottingham, feel that in her passing they have lost a personal friend.

S. A. S. M.

THE BRITISH EDITORIAL BOARD

SUCCESSION OF CHAIRMANSHIP

PROFESSOR GEORGE PERKINS

Professor George Perkins has just retired from most of his duties in directing the orthopaedic service of one of the greatest of the London teaching hospitals while at the same time being the first orthopaedic surgeon in Britain to occupy a chair of general surgery. This professorship he has fulfilled with very great distinction. In withdrawing from the more active of these responsibilities he has sought also to retire from the chairmanship of the British Editorial Board of this Journal, handing the task to Professor Walter Mercer, president of the Royal College of Surgeons of Edinburgh.

GEORGE PERKINS
Retiring Chairman of the British Editorial Board

George Perkins is in vigorous and flourishing health. His wit is as sharp as ever. His understanding is as great as ever—and it should be added that few of those who may sometimes have experienced the occasional lash of his wit have failed to know the warm and kind understanding behind it. None who was ready to be criticised, shall we say to be debunked, ever found a greater friend than him. Certainly this Journal never found a greater friend. Without him there would probably not have been a British Volume of the Journal of Bone and Joint Surgery. It was he who inspired it despite early doubts and sometimes opposition. He was intimately concerned with all the first developments in the very early conversations of Robert Jones so long ago, in discussions with Norman Capener and Jackson Burrows, in negotiations at the Café Royal, in the home of Rowley Bristow, in the Royal College of Surgeons of England, and finally at House-in-the-Wood. Since then, almost from the beginning until now, he has been Chairman of this Editorial Board.

A few days ago the British Orthopaedic Association paid tribute by making him an Emeritus Fellow—that is to say not one who has retired but one who has deserved great recognition for his achievement. The British Editorial Board would also pay tribute and it has tried to do so by associating this issue of the Journal with his name and dedicating it to him in the trust that his alert wisdom and sound commonsense will long be available to us.

REPORT OF THE BRITISH ORTHOPAEDIC ASSOCIATION ON POLIOMYELITIS

AN ORTHOPAEDIC PROBLEM

Sporadic poliomyelitis has been recognised in Great Britain for 150 years. The first recorded epidemic did not, however, occur until 1911 when there was a sharp local outbreak in Devon and Cornwall. Other local epidemics followed at intervals, but in 1947 there was a widespread outbreak when over 7,000 cases were notified. Since then further similar outbreaks have occurred and the British Orthopaedic Association is concerned about the arrangements for dealing with these large-scale epidemics.

Before the first world war orthopaedic surgeons usually saw patients with poliomyelitis only after deformity had developed. They appeared in out-patient clinics as cripples who required operative correction of deformities that had developed as a result of loss of muscle balance. It is known that many of these deformities could have been prevented by adequate early treatment and regular supervision over a period of years. Legislation such as the Fisher Act of 1918 encouraged the development of clinics and special hospitals for young "cripples" with the result that children who had suffered from poliomyelitis came under more comprehensive supervision and treatment. Useful links were formed in many parts of the country between orthopaedic and infectious diseases hospitals; orthopaedic supervision was instituted in the acute stage of the disease and continuity of treatment was ensured when the patient was transferred either to the orthopaedic hospital or to his home. In consequence there was a striking improvement in the condition of patients who had suffered from poliomyelitis, and the orthopaedic surgeon was able to confine his surgical activities to reconstructive as opposed to corrective operations.

The recent increase in numbers of cases of poliomyelitis demands revision of the arrangements which had worked well up to 1947. The parallel increase in bulbar and respiratory complications—which have probably always been present in about one-third of the paralytic cases—has led anaesthetists and laryngologists to take an active part in the management of the acute disease, an interest which is extremely welcome to the teams with which they have worked for many years past. It is, however, with some concern that the British Orthopaedic Association detects a tendency to jettison the clinical and administrative experience slowly gained over several decades. It appears that the undoubted need for skilled attention and special equipment in the care of patients with bulbar and respiratory paralysis has led to suggestions that patients suffering from poliomyelitis should be admitted to hospitals where these special facilities predominate rather than to infectious diseases hospitals where a full team is available. The Association feels bound to emphasise that in view of the recent evidence of increased infectivity of poliomyelitis there is a danger that such a policy may in fact materially aggravate incidence of the disease. The Association therefore suggests that it would be preferable to improve and expand facilities for the treatment of acute complications of poliomyelitis without placing the welfare of the individual above that of the community. A reasonable way of doing this, which has already been adopted in certain Regions, is to select suitable infectious diseases hospitals as centres for the reception of patients suffering from poliomyelitis, and to equip them with the facilities required by the specialist responsible for dealing with dangerous complications: and to staff them with a team which will also be available outside the hospital. In this way proper isolation is secured and transfer of patients, at the stage of the disease when ordinary transport by ambulance may endanger life, would be avoided.

The infectious diseases hospital has yet another advantage in that it has no waiting list at any time of the year; there are always facilities for immediate admission; there is none of the awkward delay and dislocation of work which is inevitable when a special unit has to be opened temporarily to deal with an epidemic or a particularly difficult case. Infectious diseases hospitals can easily be linked administratively with large general hospitals, thus avoiding the creation of a special staff which might be unemployed for long periods.

The arrangements which exist in many parts of the country whereby the appropriate orthopaedic surgeon is informed immediately of the admission of a patient with poliomyelitis to the infectious diseases hospital enable the orthopaedic department or hospital to adjust its admissions so that there is no undue accumulation of patients in the infectious diseases hospital. They ensure, moreover, that there is adequate early treatment of the paralysis during the most important initial stages when contractures often develop rapidly, and they lead automatically not only to continuity of treatment and rehabilitation throughout the whole phase of recovery, but also to the patient's training and settlement in a suitable occupation. It is suggested that this plan whereby the orthopaedic services are engaged from the beginning should be adopted on a national basis.

The Association is disturbed by the recent tendency to regard the potentially lethal aspects of the disease as predominant in the determination of the plan of treatment. Life is more important than limb, but poliomyelitis is still above all things a crippling disease. Limbs as well as lives have to be saved. Every patient should have the benefit of the special skill of the infectious diseases physician, the orthopaedic surgeon and of specialists qualified to deal with the respiratory complications. They can work together in harmony everywhere as, fortunately, they do now in many centres and regions.

PROCEEDINGS AND REPORTS OF UNIVERSITIES, COLLEGES, COUNCILS AND ASSOCIATIONS

GREAT BRITAIN AND IRELAND

ROYAL COLLEGE OF SURGEONS OF ENGLAND

SIR HARRY PLATT, P.R.C.S.

Until recent years few surgeons holding specialist appointments at a teaching hospital were elected to the Council of the Royal College of Surgeons of England. The election of Sir Harry Platt indicated that his surgical status, administrative ability and personality were widely known and that he was the leader of British Orthopaedics of the day.

A confidence developed amongst orthopaedic surgeons who realised they had a representative on the Council who would further the development of their craft on the principles of Robert Jones. During his tenure of office on the Council it is well known that Sir Harry has carried out much public work with ability and has acquired great knowledge of many matters connected with our profession. Consequently, it was fitting that the Council should have appointed him President in the summer of 1954.

He has shown a vigorous and forceful attitude in the many appointments he has held. During his talented career some of his outstanding achievements have been the formation at Ancoats Hospital of the first organised fracture clinic in England, his work as Consultant to the Lancashire County Council, particularly in advising the Education Committee, when implementing the Fisher Act in 1918, and in his work at Biddulph Grange. It should be appreciated that his appointment in 1932 as orthopaedic surgeon to Manchester Royal Infirmary was the vital factor in the development of a department which in so short a time has acquired an enviable reputation. It was appropriate that the University of Manchester appointed him to a professorship in orthopaedics based on this hospital, especially as he advocated the existence of a " university " hospital, an idea that probably arose during a sojourn at Massachusetts General Hospital over forty years ago. This enabled him to express a progressive attitude towards research at the university hospital in all branches of medicine.

Professor Sir HARRY PLATT
Elected President Royal College of Surgeons of England.

Platt's reputation as a clinician is due to his work on the surgery of peripheral nerves, on the hip in children and on the treatment of recurrent dislocation of the shoulder. In this his name is usually associated with Putti. But his life's study on bone tumours has enabled surgeons to understand in a simple manner their pathology, treatment and prognosis.

The British Orthopaedic Association owes a great debt to him for his inaugural work as first Secretary in 1918, when he was closely associated with Robert Jones and Muirhead Little, and for his help in the publication of the first number of the *Journal of Orthopaedic Surgery*. During his presidency of the Association he gave thought to university teaching and the instruction of undergraduates in orthopaedics, which led up to an important memorandum in 1943; he postulated the basic necessities for postgraduate training, the function of the university undergraduate teaching schools and the provision of examiners who held appointments in orthopaedic surgery.

The State has benefited by his work for the Ministry of Health; and his influence in planning in the north of England, since the formation of the National Health Service, has been considerable. His national work was rewarded by a Knighthood in 1948 and the vision he has shown regarding the future of surgery was undoubtedly a factor in his election to the office of president of the College.

The surgical world will wish him success and will study with interest and enthusiasm the contribution he is able to make towards the advancement of the administration and direction of science whilst holding this high office.

ST J. D. B.

SCIENTIFIC SOCIETIES AND REGIONAL ORTHOPAEDIC CLUBS

THE BONE AND TOOTH SOCIETY

The Bone and Tooth Society held a Casual Communications Meeting at the Institute of Orthopaedics on June 3, 1954. Dr C. E. Dent was in the chair.

Metabolic investigation of treated Fanconi syndrome—*Dr P. D. Saville* described the metabolic investigation of two cases of the Fanconi syndrome which had been on balance for calcium, phosphorus and nitrogen for eleven and twelve six-day periods respectively. The results of treatment were excellent in both cases. The lesions requiring treatment were, firstly, acidosis, and secondly, low serum inorganic P, whilst balance charts demonstrated high urine calcium. The effects of correction of the acidosis were demonstrated. There was an immediate 50 per cent drop in urine calcium when 20 grammes sodium bicarbonate was given daily. Sodium bicarbonate was given in preference to Shohl's citrate solution because it was known from previous metabolic work that calcium absorption in normal individuals was unaffected by administration of alkali or acid, so that administration of citrate seemed pointless. Calciferol maintained calcium and phosphorus absorption but increased urine calcium proportionately, and it was only when alkalies were given in addition that the patients went into positive balance for calcium and phosphorus. The administration of large doses of sodium bicarbonate caused hypokalaemic symptoms in the adult patient, which were corrected by substituting potassium for some of the sodium.

Interference microscopy in bone histology—*Dr H. G. Davies* spoke on the application of interference microscopy to bone histology. He described how the mass of substances, other than water, in tissues can be calculated from measurements of optical path (product of refractive index and thickness) made with an interferometer microscope. This technique had been used to study the distribution of substance in thin sections of adult human femur (compacta) and the results were compared with those obtained by the x-ray microradiograph technique. The

varying degree of mineralisation demonstrated by interferometry agreed with what had earlier been shown by x-ray microradiography. Interferometric studies of decalcified bone showed little variation in the organic content of the Haversian systems and the regions surrounding them. Using the interferometer microscope method the average density of the intact bone tissue was found to be about 1·9, and this is in good agreement with the values 2·0–2·1 obtained by conventional methods on macro-samples of bone.

Calcium exchange in bones and teeth—*Dr D. H. Tomlin* presented a paper by *Dr K. M. Henry, Dr S. K. Kon* and himself on the autoradiographic study of calcium exchange in bones and teeth. The entry and subsequent removal of dietry 45 calcium in non-growing regions of cortical bone and incisors of three-month-old rats had been studied quantitatively by deriving specific activities from micro-densitometry of autoradiographs. Rats were killed at intervals during and after the administration of radioactive diet. By using, as standards, bones from rats which had been given the radioactive diet from weaning, and so contained large regions with a specific activity corresponding to 100 per cent incorporation of the dietary calcium, it was possible to calculate the percentage exchange of calcium as a function of time on radioactive diet. The percentage exchange in cortical bone reached 2 per cent after two weeks, but this figure did not fall below 1·8 per cent after a further ten weeks on non-radioactive diet. The exchange of calcium in the incisors was hardly detectable, and estimated as less than 0·2 per cent in two weeks. The results are compatible with a reversible exchange process in which the exchanged atoms become homogeneously distributed throughout the bone crystals in a time of the order of a few hours

The localisation of radioactive strontium and yttrium in the skeletons of rabbits and monkeys of various ages—*Miss J. Jowsey* read a paper compiled by *Mrs M. Owen, Dr J. Vaughan* and herself. In old animals strontium was concentrated in the lowly calcified areas around Haversian systems and building sites, producing the streaks of intense reaction seen in longitudinal sections. In young animals strontium was concentrated in epiphysial trabeculae and particularly in calcifying cartilage, as well as endosteally in the metaphysis and periosteally in the diaphysis. All areas of deposition remained unless the bone in which they lay was resorbed in the process of growth. Yttrium was found associated with the Haversian blood vessels in both young and old animals, which accounts for the dotted appearance in the macroscopical longitudinal sections. These microscopical investigations gave an indication of the hazard due to radiation to be expected in different regions of the bone. They show that by far the greatest uptake of both yttrium and strontium occurs in areas of local concentration and is not due to an exchange mechanism on crystal surfaces.

NORTH-EAST METROPOLITAN ORTHOPAEDIC CLUB

The first meeting of the North-East Metropolitan Orthopaedic Club was held at St Margaret's Hospital, Epping, on July 3, 1954, under the chairmanship of Mr H. Osmond-Clarke. Clinical cases were shown.

Osteitis fibrosa cystica—*Mr A. Baron* discussed two patients successfully treated by removal of parathyroid tumours. In the first case the initial manifestation was a cystic swelling of the right ilium; the second case was diagnosed radiologically when routine examination of a knee was carried out after a minor injury. The position of the tumour was demonstrated by barium swallow.

Coxa vara in infants—*Mr G. R. Fisk* showed a case of congenital dislocation of the hip, treated at the age of two by open reduction with good subsequent function, but the development of a mild coxa vara. The untreated hip showed a subluxation with anteversion of the femoral neck. An interesting discussion followed, in which it was generally considered that both hips should be left alone for the time being. A second case of infantile coxa vara was shown, in which the ossifying femoral heads were of a flocculent appearance. Although no other bone change was present, it was suggested that this was a manifestation of a generalised bone dystrophy, but that the local deformity should be corrected by abduction osteotomy within the next year.

Osteomyelitis—Two unusual cases were shown by *Mr D. A. Reid*. In the first case a low grade osteomyelitis of the femur, treated conservatively by prolonged penicillin therapy, had caused absorption of the femoral shaft and sequestration of the femoral head. The shaft had completely re-formed, and the neck, after being placed in the acetabulum, had taken part in a pseudarthrosis, with excellent function and seemingly with the formation of an epiphysis. In the second case, neonatal osteomyelitis of the ulna had caused complete sequestration and extrusion of the shaft, with the re-formation of a new one from the involucrum; but later there was gradual dislocation of the radial head and stretching of the dorsal interosseous nerve, with wrist drop. The case presented a serious problem of treatment, and many suggestions were made, including implantation of the upper end of the ulna into the lower end of the radius.

Hyperextension fracture of the humeral neck in adolescence—*Mr Fisk* showed a case in which the humeral shaft had penetrated the deltoid, but the acute anterior angulation could be seen only in the axillary view. In one case, open reduction and screw fixation were necessary. Treatment in abduction and flexion was advised.

Acro-osteosclerosis—*Dr G. Herrnheiser* showed radiographs of sclerosis of the cortex of the phalanges of the hands, perhaps related to melorheostosis and osteopoikilosis. The condition does not seem to have been described before.

Morquio-Brailsford's disease—A case in which there had been a thirty-year follow-up was also shown by Dr Herrnheiser.

SOUTH-EAST METROPOLITAN REGION ORTHOPAEDIC CLUB

A meeting was held on May 29, 1954, at the Princess Alice Hospital, Eastbourne. About thirty-five members and guests enjoyed a varied demonstration by Mr S. A. Jenkins and Mr L. A. H. Snowball.

Broken guide wire during nailing operation—During a nailing operation for slipped upper femoral epiphysis the guide wire was broken, leaving a length of about one inch in the floor of the acetabulum and one inch in the femoral head. Mr Jenkins had withdrawn the nail and the remainder of the guide wire. At a second operation he located the guide wire through an anterior incision by exploring the front of the femoral neck and had succeeded in withdrawing the guide wire from the acetabulum and the hip joint until it lay across the epiphysial cartilage, partly in the femoral head and partly in the femoral neck. Here he left it and this operation was followed by satisfactory fusion of the epiphysis. The guide wire in use was graduated by notches cut in its surface and Mr Jenkins considered that this was a dangerous type of wire, which he had now given up.

Mr D. Coltart drew attention to the method of preventing breakage of the guide wire by rotating it at intervals during insertion of the nail. If the wire became bent it would no longer rotate and the nail should at that stage be withdrawn before the wire broke.

Old Kohler's disease with varus deformity of the foot—The discussion which ensued led to some doubt about the diagnosis in this case. Other members had followed up cases of Kohler's disease without finding any examples of permanent deformity.

Debridement of knee for advanced osteoarthritis—The patient had a synovectomy, with excision of the patella and of osteophytes with a very satisfactory result. Members agreed that it was impossible to forecast in advance the outcome of this operation, but all were agreed that it had a place in the treatment of advanced osteoarthritis of the knee.

Pseudo-fracture or stress fracture of the femoral neck—The fracture involved the upper cortex of the femoral neck only and united rapidly without callus formation. There had earlier been a similar fracture of the opposite femoral neck.

Mr Coltart drew a distinction between stress fractures, which unite with callus, and pseudo-fractures which unite without callus.

Digital nerve tumour and slipping extensor tendons in the same patient—A large fusiform neuroma of a digital nerve had been removed with good subsequent function, including complete sensory recovery. This patient, a keen pianist, had also complained of symptoms apparently due to slipping of extensor tendon bands over the fifth metacarpal head. On exploration the tendon had been found to consist of four separate slips, and Mr Jenkins had relieved the symptoms completely by detaching one of these slips and passing it round the rest in the form of a sling to hold all the tendon bands on the inner side of the metacarpal head.

Divided flexor pollicis longus tendon—*Mr Jenkins* had obtained good results in two cases, one treated by tendon graft and one by tendon suture. These two cases provoked a discussion on the length of time it is safe to keep a pneumatic tourniquet on an upper limb without deflating it. Mr Jenkins was in the habit of deflating the tourniquet after one hour, and found that firm bandaging of the hand with a sterile crepe bandage was of great assistance in preventing flooding of the wound before the tourniquet was reinflated. *Mr H. L.-C. Wood* and others had also regarded an hour as the maximum safe period and had been in the habit of completing the operation without a tourniquet. *Mr J. H. Mayer*, on the other hand, considered it quite safe to continue with the tourniquet inflated for two or two and a half hours and reported no complications using this method. No one present was able to recall a case of tourniquet paralysis attributable to the prolonged use of a pneumatic tourniquet, and it was finally agreed that one and a half hours was almost certainly a safe period.

Calcaneal spur—Pain in the heel had been relieved in this case after excision of the calcaneal

spur but it was generally agreed that the pain is caused in these cases by changes in the plantar soft tissues attached to the calcaneum and not by the spur itself.

Spontaneous fracture of the first rib—A man of twenty had sustained a trivial injury to the left shoulder when swimming ten days before. Immediate pain had subsided during the next few days, but three days before the meeting he felt sudden severe pain in the left shoulder region when lifting a sack of cement on to the opposite shoulder. When seen at hospital there was much diffuse tenderness and spasm around the left shoulder, the maximal tenderness lying over the first rib. Radiographs showed an area of irregularity at the inner margin of the first left rib near its anterior end. No fracture line was visible and no other bony abnormality was revealed at that time. Mr Jenkins had seen a similar case before which had proved later to be a stress fracture of the first rib, and he felt sure that the case under consideration would follow a similar course.

It is understood that since the meeting further radiographs showed a more definite lesion with increased callus formation comparable to stress fractures in other situations. After three weeks the pain had completely subsided and he has now returned to full work as a heavy labourer.

SOUTH-WEST ORTHOPAEDIC CLUB

A meeting was held at Truro on May 29, 1954.

Miscellaneous cases—*Miss E. May* presented four cases of congenital scoliosis, two cases of post-poliomyelitic scoliosis and a case of Calvé's disease in a child of three.

Mr R. N. Grant showed the following: 1) a woman with acromio-clavicular dislocation in which the outer third of the clavicle had been excised and the medial two-thirds had been tied down to the coracoid process with nylon. The functional and cosmetic results were excellent. 2) Bilateral cystic disease of the scaphoid bone with marked pain. Curettage of the cysts and insertion of iliac chips had produced a cure. 3) A boy of sixteen with a stiff lumbar spine and spasm of hamstrings for diagnosis. He had grown three inches in one year. Possible diagnoses mentioned were prolapse of an intervertebral disc and a subarachnoid cyst. 4) Non-union of the mid-shaft of the femur after intramedullary nailing. 5) A case of sabre tibia due to congenital syphilis in a boy of six.

Mr W. W. Rentoul showed the following cases: 1) A "follow-up" case of slipped upper femoral epiphysis. After acute gross displacement a manipulative reduction and nailing had been done. Two years later avascular necrosis developed. 2) A tuberculous focus in the neck of the femur in a boy of two, successfully treated with streptomycin. 3) A girl of seventeen with a tumour of the base of the second right metacarpal. Possible diagnosis was osteoclastoma. 4) A case of bilateral osteoarthritis of the hip in which a Judet prosthesis had been inserted on both sides. The right prosthesis fractured after a year at the junction of the stem and the cup and another stainless steel prosthesis of the Fitzgerald type had been inserted. 5) A boy of seven with congenital absence of both legs and fixed flexion deformity of both short thigh stumps. He had been successfully treated by Souttar's fasciotomy and the fitting of apparatus of original design, which enabled him to walk with two sticks. 6) A boy of six with a congenital upper radio-ulnar synostosis. 7) An unusual tumour of the upper third of tibia in a girl of thirteen. At biopsy a large cavity containing fluid was found. The lining was scraped. Dr Hocking filtered the fluid and obtained a small piece of tissue which on section had the appearance of an osteoclastoma. After consideration by the Pathologists' Panel the diagnosis of unicameral bone cyst was made. 8) A case of pleomorphic synovioma of the first interspace of the right hand, treated by amputation. The tumour had been completely insensitive to x-rays.

Treatment of ankylosing spondylitis by radiotherapy—*Dr J. A. G. Hair* presented a report of 118 cases of ankylosing spondylitis treated by him with deep x-rays during the last eight years. One hundred and one patients were men and seventeen women. A predisposing factor appeared to be immobilisation: some patients in sanatoria or those immobilised in plaster for fractures appeared to be very susceptible to the disease. He had some evidence of a familial incidence of the disease and was pursuing this line of inquiry.

There appeared to be two types of case: 1) acute with severe pain; 2) insidious—in which stiffness developed with slight or no pain. The shortest period of symptoms before treatment was four weeks—the longest thirty-five years. The youngest patient was seventeen, the oldest sixty-six. In twelve cases the radiographic changes were confined to the sacro-iliac joints. In sixty-eight the spine and sacro-iliac joints were involved; and in thirty-eight the spine and other joints were affected. The erythrocyte sedimentation rate was often raised. He considered it important to eliminate any obvious focus of infection. He emphasised the value of deep x-ray therapy but believed in treating the spine in sections, the sacro-iliac joints first. Sometimes this precipitated a flare and pain was felt over the ischial tuberosities, greater trochanter and lowest

ribs. He did not believe that braces should be worn as he did not feel that they prevented deformity, and their constricting effect made it difficult for the patient to perform a job efficiently. He regarded recurrence of pain as an indication of activity. Ninety-one patients after five years were symptom-free. Twenty-seven patients were still under treatment.

Mr J. G. H. James mentioned a case of a woman in whom there had been an exacerbation of the spondylitis at each of three successive pregnancies. *Mr John Bastow* said that the erythrocyte sedimentation rate was not a great help in deciding the activity of the disease, but he felt that the condition was likely to recur in those in whom the rate was high.

Excision of the clavicle—*Mr A. W. Fowler* said that the functions usually ascribed to the clavicle were those of the muscles attached to it. All surgical lesions of the clavicle could be treated by partial or complete excision of the bone. To avoid impingement of the cut end during elevation of the shoulder, at least half of the clavicle should be resected. An exception to this was at the outer end where an intact coraco-clavicular ligament would prevent impingement after resection. An ununited fracture of the clavicle united after resection of the pseudarthrosis without obliteration of the clavicular bed.

Osteoarthritis of the hip—*Mr R. N. Grant* recognised two classes of patient—the younger active argicultural worker on whom he preferred to carry out a displacement osteotomy, and the patient over sixty-five in whom he inserted a prosthesis of the Newton-Fitzgerald type. In all cases he delayed operation as long as possible and, in some instances, made use of deep x-ray treatment to relieve pain.

Cervical spondylosis—*Mr D. M. Jones* described the changes in the spine in cervical spondylosis. He showed x-rays and photographs of a post-mortem specimen of cervical spondylosis in which there had been subluxation of the second cervical vertebra on the third of unknown etiology. The plane of slipping was between the disc of the affected intervertebral space and the vertebra below. The annulus was thick and presumably obtained its nutrition from healthy bone above. Subluxation occurred in cervical spondylosis and he felt that degeneration spread up the cervical spine from below, resulting in partial slipping and partial fusion of the affected vertebrae. Sir Russell Brain had shown that movement in a stiff spine could affect the spinal cord, and it was this partly mobile and stiff spine which caused trouble. A cervical spine that was completely stiff seldom gave rise to complications.

Mr Norman Capener doubted whether the spread of degenerative processes in the cervical spine was a continuous one from below and said that in some instances there was a clear interval between affected vertebrae. For this reason he felt that manipulation of the neck in the early stages to preserve mobility was a valuable procedure.

Mr J. F. Bourdillon said he had seen a patient with cervical spondylosis who had neuropathy and had in fact been seen by Sir Russell Brain. The patient had physiotherapy and as the neck became mobile the spastic condition of the legs disappeared.

Tuberculosis of the spine—*Miss E. May* reviewed all the cases of tuberculosis of the spine treated between 1935 and 1954 (112 cases—eighty-seven in adults and twenty-five in children). Children and adults with severe lesions were treated on frames. The remainder were treated in plaster spicas or spica jackets. In lesions above the eighth thoracic vertebra a shoulder spica was used and in those below the first lumbar vertebra, a hip spica. The advantages were: 1) that patients could be turned easily; and 2) that movement of the patient was possible, resulting in less deformity of the spine and an absence of complications. In one series thirty-two bone grafts were done, none in patients under sixteen. Three months after grafting the patient was allowed up in a jacket. Streptomycin was not used in most of the cases but was now used universally. No case of amyloid disease occurred in the series. Results: 59·8 per cent of the patients were at full work; 13·4 per cent were on light work; 17·8 per cent could not do any work. These figures compared favourably with those of Dobson and of Girdlestone. In twenty-three cases there was evidence of cord pressure, but only two patients had permanent paralysis. A costo-transversectomy was done in one case. The conclusions reached were: 1) That the general and local condition of the patient was better when treated in a plaster jacket; 2) that a bone graft in the late stages was of great advantage to the patient as no splintage was required after one year. The mortality was 9 per cent. *Mr T. Price* said that there was no point in giving streptomycin as a routine in all cases but that it should be given to saturation point shortly before a grafting operation.

Syme's amputation—*Mr W. W. Rentoul* stated that at a recent orthopaedic meeting at Buxton opinion was mixed as to the value of the Syme's amputation. He believed that it was the operation of choice if it was possible to perform it and went so far as to say he felt it was " a crime against the patient to perform a below-knee amputation in such case." A patient with a Syme's amputation had a weight-bearing stump and was able to get about the bedroom and the house without a

prosthesis. The Ministry of Pensions was largely responsible for the impression that it is an antiquated operation, the reason being that their limb manufacturers could not make a satisfactory Syme's prosthesis. The De Soutter prosthesis was most satisfactory and one patient had been wearing one of this type for twenty-one years, carrying 2-cwt. sacks on his back. Recently he had been provided with a Ministry of Pensions prosthesis which was unsatisfactory. The Syme operation as modified by Elmslie in his opinion was the most satisfactory procedure. The tibia was amputated three quarters of an inch proximal to the articular surface of the ankle. This obviated the bulbous extremity on which it was difficult to fit an artificial limb.

Spastic valgus foot—*Mr R. Merryweather* reviewed fifty cases of spastic valgus foot. The review was confined to those cases occurring in adolescence, and its intention was to provide a reasonable classification whereby a prognosis might be made at the beginning of treatment. The various types of tarsal anomaly (intertarsal fusion) were described and examples shown. It was pointed out, however, that more than half of the patients in the series had no anomaly of the tarsal bones. The importance of thorough radiographic investigation and examination under anaesthesia was stressed.

The classification was as follows: *Type* 1 (32 per cent)—Spastic valgus without tarsal anomaly or osteoarthritic change, attending at an early age with a short history. A cure can reasonably be expected. *Type* 2 (22 per cent)—Spastic valgus without tarsal anomaly but with, or developing, osteoarthritic change. Such patients do not regain subtalar movement but may well be relieved of pain by conservative treatment. Triple arthrodesis is occasionally necessary. *Type* 3 (38 per cent)—Spastic valgus with tarsal anomaly. Subtalar movements are permanently absent, therefore protection can often be dispensed with much earlier than in Types 1 and 2 provided pain has been relieved. *Type* 4 (8 per cent)—Osteochondritis dissecans in the ankle or subtalar joint accounted for two of the cases, but the other two were due to infective lesions.

LEEDS REGIONAL ORTHOPAEDIC CLUB

A meeting was held at Castleford on April 2, 1954.

Injuries of the cervical spine—*Mr A. J. S. Bell Tawse* showed seven cases of fractures and dislocations of the cervical spine. The mild ones were treated by reduction and immobilisation in a plaster jacket for twelve weeks; any subsequent instability of the neck was treated by fusion of the dislocated segments by bone grafts. The complete dislocations, with or without paraplegia, were treated by skull traction; but if reduction by traction proved impossible, resort was had to open reduction and segmental bone grafting.

Intramedullary nailing for fractured femur—A series of patients whose fractured femurs had been fixed by intramedullary nailing was shown. They included transverse and uncomplicated spiral fractures, ununited fractures and pathological fractures caused by secondary neoplasm. The only operative hazard encountered was impaction of the nail, and this was always released by a single longitudinal saw cut into the medullary cavity. The average stay in hospital for simple fractures was four weeks and the average time for return to work was fourteen weeks.

IRISH ORTHOPAEDIC CLUB

The Club met in Dublin on June 26, 1954, with a large attendance. The morning session was spent at Dr Steevens' Hospital, where an interesting series of cases was shown, mostly by Mr A. Chance and Mr J. E. C. Cherry. The afternoon was spent at St Mary's Open Air Hospital, Cappagh, where Mr H. F. MacAuley and Mr J. F. O'Sullivan showed a large and varied selection of cases which gave rise to much discussion.

FINLAND

DEVELOPMENT OF ORTHOPAEDIC SURGERY IN FINLAND

Orthopaedics in Finland, as in other European countries, has developed in connection with activities for the care of crippled. The Association for the Aid of Crippled was founded in 1892, and in 1900 its out-patient clinic was opened. In 1926 the orthopaedic hospital of the association with twenty-six beds and with an orthopaedic workshop was working. Head of the hospital was Dr Fabian Langenskiold, lecturer in surgery. Such was the situation when the Finnish-Russian war of 1939 broke out. After the war initiative was taken by the government to solve the difficult problem of war invalids, and in 1940 the Invalid Foundation, financed not only by the State but also by invalid organisations and insurance companies, was established.

The next step was to build up a rehabilitation centre, and that was done during the second Finnish-Russian war. In 1943 the splendid Rehabilitation Centre of the Invalidfoundation, with an orthopaedic hospital (now 300 beds), a department for physical training, an orthopaedic

workshop and all kinds of vocational schools, was opened. The founder of the Invalidfoundation, the president of its board of directors, the projector and director of the rehabilitation centre and head of its orthopaedic hospital is Fabian Langenskiold, emeritus professor of surgery. The pioneer work of Langenskiold was soon followed by rapid activity in the field of orthopaedic surgery.

At the University of Helsinki orthopaedic surgery became a compulsory subject in general medical education in 1947. There is no professorial chair for orthopaedics; but when K. E. Kallio, who had been working as associate surgeon at the Invalidfoundation from its very beginning and who already was teacher of orthopaedics for medical students, was appointed to the chair of surgery in 1950 he naturally concentrated his work on orthopaedic surgery, and his clinic is now the University Orthopaedic Clinic.

At the surgical department (Surgeon-in-Chief, M. Sulamaa, lecturer in surgery) of the University Children's Clinic (Head, A. Ylppo, professor of paediatrics) orthopaedic surgery in connection with children's surgery is represented. At the University of Turku Professor A. R. Klossner is responsible for all surgery.

There are qualified orthopaedic surgeons at hospitals as follows: Deaconess Hospital, Helsinki—Dr G.-W. Wallgren; Hospital of the Rheumafoundation, Heinola—Dr K. Vainio; State Hospital, Seinajoki—Dr P. Torppi; General Hospital, Tampere—Dr O. Leikkonen; Municipal Hospital, Lahti—Dr S. Vainio; Municipal Hospital, Lieksa—Dr P. Anttinen. The training of orthopaedic surgeons demands full competence in general surgery and three years' residentship in orthopaedics. There are at present seventeen qualified orthopaedic surgeons in Finland.

LIST OF QUALIFIED ORTHOPAEDIC SURGEONS 1954

Anttinen, P., Chief Surgeon, Municipal Hospital, Lieksa.
Barner-Rasmussen, S., Bulevardink 12, Helsinki.
Hagelstam, L., M.D., Associate Surgeon, Orthopaedic Hospital, Invalidfoundation Rehabilitation Centre. Lonnrotink 7, Helsinki.
Kallio, K. E., M.D., Professor of Surgery. Head, Orthopaedic Clinic, University of Helsinki. Tehtaank 11.B.16., Helsinki.
Kivilaakso, R., Siltasaarenk 6.A., Helsinki.
Langenskiold, A., M.D., Lecturer of Surgery. Associate Surgeon, University Surgical Clinical II. Tahtitornink 14, Helsinki.
Langenskiold, F., M.D., Emeritus Professor of Surgery. Head, Orthopaedic Hospital of the Invalidfoundation Rehabilitation Centre. Tehtaank 1, Helsinki.
Laurent, L. E., M.D., Mannerheimintie 21–23, Helsinki.
Lehtovaara, E., Associate Surgeon, Orthopaedic Hospital, Invalidfoundation Rehabilitation Centre.
Lofgren, L., M.D., Udenmaank 7, Helsinki.
Malm, P., Lonnrotink 3, Helsinki.
Nyberg, L. O., Erottaja 7, Helsinki.
Pylkkanen, P., Kuusitie 7, Helsinki.
Torppi, P., Associate Surgeon, State Hospital, Seinajoki.
Vainio, K., Chief Surgeon, Hospital of the Rheumafoundation, Heinola.
Vainio, S., M.D., Associate Surgeon, Municipal Hospital, Lahti.
Wallgren, G.-W., Head, Salpausselka Tb-Sanatorium, Lonnrotink 15, Helsinki.

FINNISH ORTHOPAEDIC ASSOCIATION

The Finnish Orthopaedic Association was founded on November 17, 1951. The president is Emeritus Professor Fabian Langenskiold, and the vice-president Professor K. E. Kallio. There are thirty-six members in the association.

The first meeting was held in December 1951 at the Invalidfoundation Rehabilitation Centre. Meetings are now held regularly in the spring and autumn of each year.

1954 meeting—On March 12, 1954, a meeting was held at the Invalidfoundation. A moving picture on the operative treatment of congenital dislocation of the hip was presented by *Professor F. Langenskiold*, describing his own method, in which the iliopsoas muscle is transplanted. (Acta Orthop. Scand. 1953, Fasc. 4, p. 295). A paper on electro-myography was read by *Dr C. Lindqvst*, who showed the new apparatus of the foundation. *Dr K. Vainio* gave an account of so-called distension dislocation of the hip in rheumatoid arthritis. A fracture of the tibial condyle treated very successfully by Perkins's active movement therapy was reported by *Dr R. Lindholm*. Sacro-iliac tuberculosis was the subject of *Dr G. Bakalim*, who reported thirty cases of tuberculosis in patients who had been treated for " conventional " low-back pain.

ITALY

MEETING OF ORTHOPAEDICS AND TRAUMATOLOGY

On the occasion of the International Days of Medicine and Surgery and of the second international exhibition of Sanitary Arts, there took place in Turin on June 4, 1954, an International Meeting of Orthopaedics and Traumatology, under the presidency of Professor U. Camera, at which many Italian and foreign orthopaedic surgeons were present.

Among the many communications made, the following were of special interest: " Etiological Diagnosis of the Low Back Pain " (with movies) by A. H. Ros Codorniu; " Myokinesigraphy in the Clinics. Results and Problems " (with movies) by M. R. Francillon; " Results and Indications in the Plastic Reconstruction of the Hip Joint with Nylon " by R. Charry; " Refrigerated Tendon Grafts " by C. Pais, *et al.*

AUSTRALIA

ROYAL AUSTRALASIAN COLLEGE OF SURGEONS

A scientific meeting was held in Sydney from August 17–20, 1953, and accounts of some subjects of orthopaedic interest have now been received.

False security in the use of antibiotics—*Mr Keith Kirkland* (Sydney), while conceding the therapeutic advance from the introduction of antibiotics, stressed the empiricism of this progress. Lack of understanding of the process of infection and of the influences relating to onset and course, together with ignorance of many features of germ physiology, particularly in relation to adaptation and variation, had reduced the clinical value. The drug, the lesion and the organism presented features limiting therapeutic possibilities. It was necessary to understand choice of drug, its dosage, and whether combination of one drug with another would imply synergism or antagonism. Even with an antibiotic, proven to be specific and used in correct dosage under correct conditions, there might be side effects, sometimes remote and not always attributed to the antibiotic. More frequent strictures after bladder-neck surgery might be an example of remote effect. Indirect toxic effects occurred mainly from an upset of the bacterial balance in healthy individuals, which might cause an increased virulence and activity of non-suspectible organisms. Stomatitis, vaginitis and proctitis occurred. Specific effects of streptomycin and dihydrostreptomycin upon the eighth nerve were examples of direct toxic effects. The pathological lesion, by influencing blood supply and vascularity, might prevent effective tissue saturation. Underlying pathology must always be assessed, and the dramatic features of antibiotic therapy did not remove the need for full investigation and clinical understanding of the related pathology. The organisms, in the face of this latest biological attack, were exploiting the faculty of all living bodies to adapt themselves. Some were immune to any antibiotic, and unresponsive to any form of therapy. Suppression in others might be achieved by destructive action by the drug or merely inhibition. Inadequate dosage or sub-lethal concentration at the pathological lesion might lead to habituation to the drug and permanent immunity. Less commonly, dependence on the drug, and occasionally stimulation to cause an added virulence, might occur. In brief, the limitations in efficacy of antibiotic therapy occurred so generally that complacency and a sense of security were quite unwarranted. In many ways antibiotics had been beneficial, but damage and toxic effects had been so frequent as to condemn their use except when absolutely necessary. The increase of resistant strains, immune to any therapeutic attack, was an unhappy augury for the future.

Mr B. Keon-Cohen (Melbourne) said that many of the ailments met with in general practice had, in the past, shown a ready response to antibiotic therapy. Their simplicity of use was an invitation to their employment for the relatively trivial illness and, often, in inexperienced hands too much was expected. First surgical principles of draining collections of pus, of removing sequestra or foreign bodies, and of resting the injured part were often neglected. Mr Keon-Cohen stressed the importance of determining the type of responsible organism and its sensitivity. He was not hopeful that the use of streptomycin and P.A.S. early in tuberculous joints would cause satisfactory healing with movement. He seldom operated on a clinicaliy active tuberculous joint.

He mentioned some of the reactions caused by antibiotic therapy—for instance slight fever, which often led to undue prolongation of administration under mistaken belief that the lesion was still active.

In discussion several speakers stressed the difficulty in selecting an appropriate antibiotic. Culture and examination of the growth from one colony might not be sufficient to establish the strain, resistant or otherwise. The use of proteolytic enzymes was thought to have a real place in making the infecting organisms more accessible to the drug. There was considerable support for the use of antibiotics as an operative cover, particularly in large bowel surgery and in plastic

procedures. One surgeon said that, if infection were possible at the site of operation, and if its occurrence were likely to be disastrous, antibiotic cover must be provided.

Dr Edgar Thomson (Sydney) recalled the common practice of operating under an " umbrella " of antibiotics, usually penicillin and streptomycin; and of giving antibiotics after operation if there were fever without thought to possible causes other than infection; of giving antibiotics of wide range intravenously in the period immediately after operation in an attempt to prevent infection which in fact might never occur; and of dispensing with adequate bacteriological control. There was ample proof that organisms acquired resistance to antibiotics, most organisms and all antibiotics being implicated. The organism most implicated was the staphylococcus pyogenes which had acquired such resistance to antibiotics that many strains were completely resistant. This antibiotic resistance was mainly a problem of hospital practice and was intimately bound up in the problem of cross-infection in hospitals. Antibiotic resistance was seen in general practice also, but less. The incidence of antibiotic resistant strains of staphylococcus pyogenes had been intensively studied in the Fairfax Institute of Pathology, Royal Prince Alfred Hospital. A summary of the more recent figures from July 1952 to June 1953 showed that, of 1,750 strains of staphylococcus pyogenes, 67·31 per cent were resistant to penicillin, 31·77 per cent to streptomycin, 19·08 per cent to aureomycin, 8·82 per cent to chloramphenicol, 19·08 per cent to terramycin, and 5·77 per cent to all antibiotics. Recently staphylococcal wound infection increased in a surgical ward. Two patients died from generalised infection with antibiotic-resistant staphylococci. In all the cases the staphylococci isolated were of identical phage type. A survey in the patients and staff of the ward revealed that twenty-eight of forty individuals were nasal carriers of the staphylococcus. Of these twenty-eight, twenty-five were carrying a penicillin-resistant strain and ten the same phage type as in the fatal cases. Of these ten people seven were patients and three were nurses. The particular strain isolated from these ten people was resistant to all antibiotics except erythromycin, which was administered. Within thirty-six hours the strain had developed resistance to erythromycin. A wider survey within the hospital revealed three cases of staphylococcal infection with the same phage type in three other wards. These were all cases of proven hospital cross-infection. Clearly it was unwise to rely completely on antibiotic therapy in the control of infection in surgical or medical wards, though antibiotics were a valuable aid to surgery if used with discretion and with adequate bacteriological control. It might be well to remember: 1) that antibiotics should be used to treat infection when it occurred and not as prophylactics to prevent infection which might never occur; 2) that we should concentrate on the prevention of cross-infection and not be lulled into a sense of false security by the widespread use of antibiotics which might lead to (*a*) death from resistant strains, (*b*) superinfection, (*c*) allergic and toxic reactions; 3) that adequate surgery was essential.

Late results of intervertebral disc surgery—*Mr Douglas Miller* (Sydney) said that his communication was based on the results in 400 patients, of whom 250 had replied to a recent questionnaire. No patient was operated on for backache alone, and usually conservative treatment had been given initially for at least one month unless disability had been very severe. Myelography was used when clinical evidence left doubt as to the level of the lesion. An inter-laminar approach was employed. There had been four deaths in 1,000 cases. Of the 260 patients questioned, 86 per cent had returned to their usual work; of these, 139 were engaged in a heavy occupation and eighty-seven in tasks requiring light physical effort; twenty-five patients changed their work and nine did no work after operation. Eleven patients complained of incomplete relief or recurrence. In four of these a disc prolapse was found on the other side. In the other seven a spinal fusion was performed with satisfactory result.

In none of the patients in whom operation failed to relieve symptoms had there been a negative exploration. All were over thirty years of age. Mr Miller found it difficult to assess disability in the failures and had no doubt that the best people gave the best results. But he had not found a larger proportion of bad results among unskilled workers, except miners, than in private patients.

In general, he regarded the results as satisfactory. Operation brought speedy relief of pain and early return to full work. He had found no necessity for spinal fusion as an adjunct to the removal of the prolapsed disc.

Mr J. R. Barbour (Adelaide) based his communications on 100 consecutive cases of exploration of the low lumbar region. Six patients had spondylolisthesis; of the others, seventy-three complained of sciatica, and twenty-one of low backache. The fourth and fifth discs were explored by an interlaminar approach. The patients got up on the third day after operation, and most were discharged within two weeks. Return to heavy work was usually delayed until three months from the time of operation. The result of operation was poor in five patients, fair in twenty-seven, and good in the remainder. Two required a further exploration, and six had primary spinal fusion. To achieve this he favoured screw fixation of the apophysial joints and an iliac bone graft. In

his opinion economic considerations frequently determined early operation and a large percentage of his patients had continued full work without subsequent breakdown.

Mr Murray Maxwell (Sydney), opening discussion, confined himself to the question of spinal fusion when removal of a prolapsed intervertebral disc had failed to relieve symptoms. He said there was far too much complacency about the results of operation to fuse vertebrae. Dr Joseph Barr had reported that an attempt to fuse more than two vertebrae had failed in 25 per cent of cases. A review of fifty-four cases of spinal fusion had revealed nine failures. In this series the results were excellent (back to heavy work) in 30 per cent, good (occasional intermittent pain) in 30 per cent, fair in 20 per cent, and poor in 20 per cent.

Mr Lennox Teece (Sydney) had been somewhat disappointed with the results of disc surgery. Many insured workers remained permanently unfit for their usual occupation. Economic considerations often prompted a conservative method of treatment that was inadequate; he favoured bed rest in a plaster spica.

Mr B. Keon-Cohen (Melbourne) also considered economic factors important in determining the treatment. If the patient could be relieved of pain by a jacket and could work in this, then conservative treatment was justified for three or four months.

Mr F. P. Morgan (Melbourne) said that he was satisfied with his results. He had found 48 per cent of good results. Those who suffered persistent backache after exploration usually fell into three categories: 1) Those who had had long-continued backache and finally developed acute sciatica for which operation was performed; 2) those with parallel displacement of one vertebra on another; 3) those with unduly lax low lumbar vertebrae. In all these cases he envisaged apophysial joint trouble, demanding fusion.

Other speakers agreed that disc prolapse must inevitably lead to mechanical changes in the apophysial joints, causing pain in some patients. Spinal fusion was the logical answer.

Uses of pedicle flaps in limb repair—*Mr D. Officer Brown* (Sydney) discussed from the plastic surgeon's viewpoint the various methods of repair with pedicled flaps, pointing out that in many instances free grafting did not provide lasting and adequate repair, and that skin flaps should be used: 1) over bare bone or cartilage, or bare tendons; 2) where continued pressure or repeated trauma is likely; 3) over areas of great functional importance; 4) where deep reparative surgery is later required, for instance grafting or nerve repair; 5) for thumb reconstruction and many other major definitive repairs of the hand.

The author briefly reviewed the pedicle repair of limbs in 180 patients in a Base Military Hospital during the three years 1945–1947. Eighty-eight had needed tubed pedicles, ninety-two a direct two-stage open flap. The latter had comprised fifty-six cross-leg flaps and thirty-six flaps to the hand and forearm. The final results were uniformly good. In no instance had a cross-leg flap been "delayed" at the first stage. This prodecure, so often recommended, was regarded as unnecessary and complicating. It was emphasised that material losses of flap skin during these procedures are due to bad design and technique, tension and haematoma. Infection *per se* is regarded as relatively unimportant. The dominating importance of the purely mechanical factors in the causation of surgical complications was fully discussed and stressed. Open plaster fixation was invariably used for cross-leg flaps, but only the simplest light elastic strapping or binder for arm flaps and tubed pedicle repairs. In almost all open flaps the donor area was grafted with a thick split graft at the time of the first operation. Anaesthesia, of vital importance, must allow the utmost co-operation from the patient during the critical recovery period. The author had invariably used spinal anaesthesia for all flap repairs of legs, and a combination of brachial block and spinal anaesthesia for the open arm and hand flaps. The details of post-operative management were stressed; good nursing was imperative; careful planning of all stages, particularly in tubed pedicle repair, was necessary to avoid uncomfortable or impossible positions and inevitable losses.

Hand repair was discussed in considerable detail, and it was urged that the main reason why hand surgery had become, to such an extent, the province of the plastic surgeon, was that skin cover and management were the dominating influence. The astonishing capacity for recovery of damaged deep structures after being adequately covered with skin was demonstrated, and on the other hand the great danger of operating for deep repair through bad skin was stressed. In several cases pedicle flap repair on a leg, as a preliminary to intended bone grafting, had led quickly to firm bony union, making bone grafting unnecessary. In the speaker's experience, the largest groups of cases in which pedicled flaps had been used were: 1) major losses about the hand and forearm; 2) severe axillary contractures; 3) open fractures, gunshot wounds and severe crush injuries of legs, with considerable skin loss; 4) tropical and other deep penetrating ulcers; 5) plantar warts with radio-atrophy, or extensive plantar scar tissue or loss from other treatment.

Repair of the sole of the foot for radio-necrosis and other conditions had been done in more

than fifty cases in the past ten years, nearly always with a cross-leg flap, and the procedure was regarded as entirely satisfactory. A close liaison between plastic and orthopaedic surgeons was urged.

The Judet operation—*Mr Tom King* (Melbourne) had seen the operation of acrylic replacement of the femoral head performed by Robert and Jean Judet. The short conservative and virtually bloodless incision of Heuter (after ligature of the lateral circumflex vessels) with no division of muscles was impressive. The operation really required the special orthopaedic table that the Judets had devised, with leg pieces that could be swung downwards or upwards so that hyperextension over a buttock-bar allowed easy dislocation for shaping the head, and flexion allowed adequate and at times excellent exposure of the acetabulum. An ingenious compressed air attachment to each foot allowed steady traction in either of these positions. A transverse and semi-circular incision in the capsule where it is attached to the acetabular rim avoided damaging the retinacular and nutrient vessels; for the same reason only about a quarter of the head was removed and the remaining three-quarters was shaped so that the neck was longer than before; this also avoided post-operative dislocations, largely caused by removing too much head and neck. Special retractors about the neck assisted dislocation; a special retractor, introduced above the rim of the acetabulum, displaced the psoas and sartorius and allowed a clear view of the acetabulum. The Judets now considered that the prosthesis with the skirt caused necrosis at the shaped circumference, and that too much of the neck was uncovered during the shaping and fitting of the head, with damage to the retinacular vessels. The new prosthesis had a broader surface and no skirt, and sat on a head divided conservatively and obliquely at about 60 degrees. Some elaborate instruments were now available; but the periacetabular retractor was essential for the acetabular exposure.

NEW ZEALAND

NEW ZEALAND ORTHOPAEDIC ASSOCIATION

1953 MEETING

The annual meeting of the New Zealand Orthopaedic Association was held at the Middlemore Hospital, Auckland, from September 2–4, 1953, under the chairmanship of Mr Leslie Will.

Management of tuberculosis of the spine in New Zealand—*Mr Selwyn Morris* (Auckland) pointed out that New Zealand was a favoured land from the point of view of tuberculosis, and the writings coming from the British Isles or the United States should not be considered too seriously. The problem in New Zealand should be settled by those practising in New Zealand alone. Mr Morris reported forty-six cases treated since 1947. Only two patients died, and in both the disease was complicated by paraplegia. One had renal tuberculosis and died of uraemia; the second died from another condition only remotely related to his original tuberculous lesion. The remaining patients, so far as was known, had returned to active civil life. Spinal tuberculosis in New Zealand was a benign chronic disease which rarely led to complications. There was a high local resistance to infection, and operative treatment was seldom necessary. Indeed it was doubtful even whether streptomycin had any useful effect. In the series presented, only six cases occurred in children between the ages of five and fifteen and only one in the early fifties. All the rest occurred during active adult life. There was nothing of importance in the location of the disease, except that there were no cases of cervical tuberculosis. Spontaneous fusion of the affected vertebrae occurred in 65 per cent of cases. The fusion was not invariably by bone, but could be classified as fibro-osseous. Spinal fusion was considered worth while only when it was thought that the spine was unstable; fusion was not necessary to promote healing. The areas where instability occurred were at the lumbo-sacral angle and in the upper thoracic spine.

The routine adopted in the treatment was first to assess the phase of the disease when the patient was admitted. Few had a raised temperature or pulse and not all had a raised sedimentation rate. If the disease was still in the invasive phase, the patient was kept in bed until the corner was turned (usually a matter of one to six months) and the healing phase was under way. He was then allowed up in a plaster jacket. Thereafter the condition was reviewed at three-monthly intervals. When the disease had clearly become inactive a spinal brace was fitted. When operative fusion was undertaken, only the diseased vertebrae were grafted, to preserve mobility in the rest of the spine. Deformity was not treated at all, only controlled. Walking in a plaster jacket did this. It allowed the affected vertebrae to squash together and compensatory curves to develop above and below the kyphos. Abscesses were treated surgically by incision, drainage and closure whenever they broke through, or appeared to be about to break through, the skin surface. Paraplegia was treated as soon as possible by costo-transversectomy or lateral rhachotomy.

Bifurcation osteotomy of the femur in the treatment of osteoarthritis of the hip—*Mr H. Walden Fitzgerald* (Dunedin) stressed that this operation still held a place in the treatment of osteoarthritis of the hip. But he preferred to rely upon internal fixation of the fragments rather than a long period of recumbency in a hip spica. He used a doubly-bent plate, held into the upper fragment by two long screws instead of a Smith-Petersen nail, and fixed by screws in the usual manner to the lower fragment.

Treatment of Pott's paraplegia—*Mr N. W. Nisbet* (Dunedin) supported Girdlestone's advocacy of operative treatment if there was no improvement in the neurological condition after a few weeks' conservative treatment. Operation had carried a high mortality, but with care and protection of the spine during and after operation, this could be reduced. In a study of nine cases of paraplegia the cause of the interruption of the spinal conduction was a mechanical compression from abscess, debris or sequestra. Three patients were treated conservatively, two of whom recovered completely after a short time, and one developed permanent paralysis. Four patients with paraplegia of early onset required spinal decompression; three recovered, but one died after pathological fracture-dislocation of the spine. Two patients with late onset paraplegia were operated upon, one with relief. The operation recommended was lateral rhachotomy.

Medial release operation for talipes equino-varus—*Mr Rex Blunden* (Christchurch) advocated this operation in cases resistant to manipulative treatment. The operation was designed to correct the abnormal relationship of talus and calcaneum, and to reduce the medial displacement of the navicular at the talo-navicular joint. Through a medial incision the neuro-vascular bundle was isolated and retracted out of the operative field. The posterior tibial tendon was completely freed of its sheath, divided by a Z-plasty and clamped out of the operative field. The tendons of the flexor longus digitorum and flexor longus hallucis were divested of their sheaths and retracted. Liberal sections of the sheaths of these three tendons were removed, thus overcoming resistance to eversion of the heel. It was important not to divide the thickened structures uniting the tibia and the talus, but the ligaments and fibrous structures were divided to clear the medial borders of the talus and calcaneum. The capsules of the dorsal, medial and inferior surface of the talo-navicular joint were divided to enable the anterior part of the subtalar joint to be exposed and the strong interosseous ligament divided. At this stage the foot could be swung outwards, allowing a further extensive capsulotomy of the posterior part of the subtalar joint. After manipulation of the foot into the correct position, the wound was closed, correction was maintained as much as skin tension would allow, and the limb put in plaster. Plaster was changed at three weeks and kept on for eight weeks. This was followed by Denis Browne's night boots and special footwear.

1954 MEETING

The annual meeting of the New Zealand Orthopaedic Association was held in Christchurch on May 26–28, 1954, under the presidency of Mr Leslie Will.

Some aspects of the management of cerebral palsy—*Dr G. A. Q. Lennane* (Rotorua) said that the treatment of cerebral palsy was based, firstly, on the theory that in a developing central nervous system alternative pathways could be trained to take the place of pathways damaged by disease or injury; secondly, on the fact that repetition of an act makes succeeding similar acts easier; and thirdly, that enlargement of the sensory experience stimulates cerebral development and motor improvement. He said that treatment should begin at an early age and was a slow progression from crawling to walking. Dressing techniques and other basic movement patterns were encouraged. Occupational therapy and speech therapy were important adjuncts. There were few indications for surgery. *Mr Morris Axford* (Auckland) found that it was difficult to advise the parents in the worse cases. *Mr Leslie Will* (Christchurch) was preparing a report of the activities of a field officer which he felt was important in home management.

Reattachment for avulsion of the distal biceps tendon—*Mr H. Smith* (Auckland) had used Bauman's method to reattach this tendon on five occasions (Journal of Bone and Joint Surgery, **1934, 16,** 966). By this method a wide exposure of the distal biceps insertion was unnecessary. Few cases of avulsion of the distal tendon had been recorded in the literature and it seemed possible that the lesion had been missed in the past. *Mr H. W. Fitzgerald* (Dunedin) and *Mr Kennedy Elliott* (Wellington) had each had one case; in the latter the tendon was ruptured above its insertion. *Mr Morris Axford* (Auckland) praised the operation, which gave uniformly good results.

Chopart's amputation—*Mr A. Macdonald* (Auckland) said that this amputation had been condemned because of an alleged inevitable plantar-flexion of the stump and development of painful callosities. He was surprised, therefore, when he discovered a member of the limb-fitting staff in Auckland with this amputation which was still giving good use after seven years. The patient had found that a block-leather socket was unsatisfactory and together they designed a

prosthesis with a perspex socket and a new type of artificial foot. *Mr W. Parke* (Gisborne) said that this amputation had not stood the test of time and he was unhappy about accepting it as a routine procedure. *Mr Leslie Will* (Christchurch) said that any amputation of the foot which loses the insertion of the tibialis anterior muscle was found to give a poor result. In closing, Mr Macdonald said that in four years there had been no failures so far and stressed the importance of the grip of the heel by the prosthesis which prevented equinus deformity.

Vertebra plana—*Mr G. M. Goodson* (Lower Hutt) said that this condition was first described by Calvé in 1924. There was no certain etiological factor. The disease was an aseptic necrosis of bone, almost invariably confined to one vertebral body. The case of a three-years-old girl was described in which the radiological changes were traced throughout its course. The onset was acute, and heralded by backache and malaena. Ultimately, with rest, the affected vertebral body regained at least two-thirds of its depth.

Coxa plana—*Mr G. M. Goodson* continued the study of osteochondritis or osteochondrosis. He said that in this disease the remarkable speed in the collapse of the affected bone was comparable only to an acute pyogenic infection. An intense hyperaemia must therefore precede this, so that there must be a rich blood supply; thus this condition differed from ordinary aseptic or avascular necrosis of bone. Histologically, too, the two conditions were different. In osteochondritis there was absorption of the trabeculae as well as their death, whereas in aseptic necrosis complete and immediate death of the trabeculae preceded the replacement. This meant that the cutting off of the blood supply could play no part in the etiology of osteochondritis. *Mr R. H. Dawson* (Palmerston North) believed that coxa plana was neither an avascular necrosis nor a hyperaemia. *Mr D. Liddell* (Wellington) described the histological findings in several cases from the American literature.

Rehabilitation of the civilian disabled—A visit was paid to the Disabled Servicemen's Rehabilitation Centre. Members of the Association were shown around the workshops and after tea a discussion was held on the rehabilitation and retraining o. the civilian disabled. *Mr Leslie Will* (Christchurch) said that he saw no reason for not using these centres throughout New Zealand for training permanently handicapped civilians as well as ex-service men.

Brucellar spondylitis—*Mr F. J. Gruar* (Whangarei) said that brucellosis or undulant fever was a general infection whose natural habitat was in domestic animals. Infection occurred by ingestion of raw milk from infected cows, handling of infected animals or by inhalation of dust carrying the organism. Bone and joint symptoms appeared eight to twelve weeks after the onset and the lumbar spine was the commonest site. The diagnosis was made by clinical findings and laboratory tests. Since these varied considerably, the radiological appearances were of great importance, especially in distinguishing between brucellosis and tuberculosis. In brucellosis there was a characteristic zone of sclerosis at the site of the original focus, a variability in the site, and extension of the lesion with sparing of the intervertebral disc. The vertebral body might retain its normal contour and show irregular sclerosis, and there might be lipping. Abscess rarely formed. Brucellar spondylitis in hog spines closely simulated these appearances. The treatment consisted in the administration of aureomycin (3 grammes) and dehydro-streptomycin (1 gramme) given concurrently in a thirty-day course, and splinting the spine in plaster or braces. The results were difficult to judge. *Mr B. M. Hay* (Hamilton) described several cases that he had treated. The radiological findings were puzzling and the Mantoux skin tests were negative, and this was an important distinguishing feature. In his cases the diagnosis depended on the agglutination titre, but it was not always possible to get a strong titre.

Acrylic prosthesis for arthroplasty of the shoulder—*Mr H. K. Christie* (Wanganui) said that it was rarely necessary to perform this operation on the shoulder, but the opportunity occasionally arose in missed dislocations, when both shoulders were stiff, after fracture-dislocations and for excision of the humeral head for tumours. He described one patient on whom he had operated recently. *Mr Kennedy Elliott* (Wellington) expressed great interest in the case and asked for a progress report at a subsequent meeting.

Reticulum-cell sarcoma of bone—*Mr W. Parke* (Gisborne) described two patients considered to have this disease. He discussed the nature of this tumour and mentioned recent American work on the subject.

Congenital kyphosis–*Mr W. Parke* (Gisborne) described three patients with this deformity. The first was associated with achondroplasia. No improvement followed hyperextension in a plaster for a year. In the second case, that of an eighteen-months-old child, the condition was associated with cretinism and social conditions precluded treatment. In the third patient, an infant, radiographs showed almost complete absence of the first lumbar vertebral body. No other skeletal abnormality was found. After about eighteen months' splinting in hyperextension the vertebral body completely re-formed.

Cervical spondylosis—*Dr G. Riley* (Christchurch), who was introduced by Mr Leslie Will, said that this disease consisted of a number of different conditions and included disc degeneration and bony hypertrophy, alteration of natural alignment and the formation of osteophytes and transverse ridges, nuclear prolapse and fibrocartilaginous protrusion; compression of spinal roots and spinal cord and subsequent degeneration of the nerve cells and tracts of the cord. The commonest level of degeneration of the cervical spine was C.5–C.7. The clinical features of spinal cord compression varied with the tracts involved and were slowly progressive. The clinical features of chronic radicular compression varied from pain and paraesthesia to more severe sensory loss and paralysis with diminished reflexes. Pain was shooting or burning in character and might be severe, and was aggravated by neck movements and coughing. The treatment was usually conservative; the neck was immobilised by splints and collars. Traction, either intermittent or continuous, was sometimes used, as was manipulation when there were no neurological signs. The general indication for laminectomy was spinal cord compression, preferably with a short history in a patient below fifty years of age. *Mr A. A. Macdonald* (Auckland) favoured conservative treatment. He had had few successes with manipulation. *Mr A. B. Mackenzie* (Christchurch) described a diagnostic test in which traction was applied to the occipital region with the patient sitting. *Mr R. H. Dawson* (Palmerston North) rarely saw patients with signs of compression of the cord. He found that patients without radicular symptoms or compression of the cord responded well to manipulation under anaesthesia. *Mr J. K. Elliott* (Wellington) thought that time and rest were the important factors and no special treatment was of much significance. *Mr R. Blunden* (Christchurch) used a simple triangular sling, which must really elevate the shoulder, combined with exercises to strengthen the shoulder girdle.

A review of the results of bone grafting—*Mr B. M. Hay* (Hamilton) said that he had studied fifty-five bone grafts in fifty-one patients, thirty-three autogenous and twenty-two homologous; five of the former and three of the latter were failures. Five of the failures required further surgery. In two autogenous grafts and one homologous graft serious infection had occurred. The remainder considered to be infected showed merely temporary skin inflammation or slight wound gaping which healed in a short time. Judging in terms of success and failure, there was little significant difference between the two methods in this short series.

Some aspects of fat embolism—*Mr A. J. Alldred* (Dunedin) said that the diagnosis of fat embolism could be made with fair certainty on clinical findings alone. The source of fat was believed to be the bone marrow, and it entered the blood stream through the venous system and reached the arterial circulation by the pulmonary capillary bed. Fat embolism was a disease of young people and the symptoms began within thirty-six to forty-eight hours. There was a change in the patient's general condition and a rise of temperature, with restlessness and breathlessness. There might be cerebral symptoms and sometimes coma and death. Incontinence of urine and personality changes were important signs. A petechial rash appeared in the skin, especially of the upper chest, neck and shoulders, and conjunctivae. Special tests had proved to be disappointing and the diagnosis in most cases was made on clinical grounds only. *Mr R. H. Dawson* (Palmerston North), *Mr A. A. Macdonald* (Auckland) and *Mr G. T. Taine* (Auckland) described cases that they had seen.

Internal derangement of the sterno-clavicular joint—*Mr Morris Axford* (Auckland) said that a twenty-four-years-old freezing worker had his left arm wrenched violently backwards when attempting to catch a falling carcase. He felt the left sterno-clavicular joint " go out " with a tearing pain. When he reported it three weeks later he said that it was going out spontaneously even without vigorous use of the arm. Examination of the joint showed only crepitus on movement and radiographs were normal. He was treated by immobilisation in a thoraco-brachial plaster for four weeks. He returned to work and had no symptoms for about a month. He reported back after two months, stating that the condition had recurred. It was decided to explore the joint. At operation the fibrocartilage was seen to be completely detached and lying free in the joint and was removed. The patient returned to work a month later. Mr Axford had not heard of a similar case and had been unable to find reference to the condition in the literature.

Congenital absence of the fibula—*Mr W. Parke* (Gisborne) recalled that this deformity was classified into three groups by Coventry and Johnson (Journal of Bone and Joint Surgery, 1952, **34–A,** 941). He described three cases that were classified as Group 2. The first patient was a man with absence of the fibula, bowing of the tibia and partial absence of the rays of the right foot. The limb was five inches short. The patient wore a prosthesis and had no disability. The second patient was a boy of nineteen years with complete absence of the right fibula and with only two rays in the foot. There was four and a half inches of shortening. The boy's psyche was upset by the deformity and he had not accommodated himself to it. A below-knee amputation was carried out. He was not yet able to assess the effect of this on the patient's introspective

outlook. The third case was that of a child in whom the diagnosis was made at birth. The right fibula was absent and the foot had only two rays. The discrepancy between the limbs was one and three-quarter inches. The right foot was later amputated one inch above the ankle. The child was fitted with an artificial limb and was leading an active life.

Tendo calcaneus bursitis (" winter heel ")—*Mr N. W. Nisbet* (Dunedin) said that this was a minor complaint and one of the causes of pain in the heel. It was due to an inflammation of the tendo calcaneus bursa. This bursa intervened between the tendon and the prominent postero-superior angle of the calcaneum, and there was an oval facet on the deep aspect of the tendon as well as on the bone. The nodding action at this point was the reason why the bursa encroached on the superior aspect of the calcaneum. The most prominent part of the heel clinically did not therefore correspond with the insertion of the tendo calcaneus but was higher than this. Most cases responded to conservative treatment and the few that did not were easily cured by a simple operation in which the prominent postero-superior angle of the calcaneum was excised, thus decompressing the tendon. *Mr A. Gillies* (Wellington) said that he had not seen the facet on the deep aspect of the tendo calcaneus. *Mr B. M. Hay* (Hamilton) warned against removing too much bone. In a patient he had operated on the tendo calcaneus ruptured a week later. *Mr H. G. Smith* (Auckland) advised a transverse crease incision because this gave a good scar.

Acute calcification in the lateral ligament of the knee—*Mr J. R. Kirker* (Auckland) described a patient with an acutely painful and tender swelling on the lateral aspect of the knee. Radiography showed a calcified deposit like that seen in supraspinatus tendinitis and occasionally in cases of " tennis elbow." The symptoms were so severe that he excised the ligament and found the calcified material to be imbedded in its substance. This operation was followed by immediate relief.

Clinico-pathological demonstration at Christchurch Hospital—The members of the Orthopaedic Association attended this meeting—a regular feature of the Christchurch Hospital—at the invitation of Dr G. L. Rolleston and Dr D. T. Stewart, heads of the radiology and pathology departments respectively. Of great interest were two cases of intra-osseous malignant synovioma, occurring in the tibiae. The radiographs showed an expanded cystic area suggesting a Brodie's abscess or tuberculosis, but the biopsy specimens showed the appearances of synovial sarcoma, including the synovial clefts containing acidophilic staining material. Dr Stewart said that most cases diagnosed as adamantinomas of bone were probably examples of this tumour.

A clinical demonstration was given by members of the orthopaedic staff of the Christchurch Hospital.

Election of officers—At the annual general meeting Mr H. W. Fitzgerald was elected vice-president, and Mr N. W. Nisbet editorial secretary. An editorial committee was formed, composed of the editorial secretary and Mr J. K. Cunninghame (Wellington), and Mr A. Alldred (Dunedin).

CANADA

CANADIAN MEDICAL ASSOCIATION AND BRITISH MEDICAL ASSOCIATION

The Canadian and British Medical Associations will hold their Annual Meeting jointly in Toronto on June 20–24, 1955. Mr Philip Wiles will be president of the Orthopaedic Section and Dr Herbert M. Coleman (206 West Block, Medical Art Building, 280 Bloor Street West, Toronto, Ontario, Canada) will be the honorary secretary. The meeting of the Canadian Orthopaedic Association will be held immediately afterwards, with a clinical day in Toronto on June 25 followed by non-clinical sessions at the Seignory Club, about half-way between Montreal and Ottawa, on 27, 28 and 29. Any visiting orthopaedic surgeons from the United Kingdom are invited to attend this meeting.

INTERNATIONAL SOCIETIES

THIRD INTERNATIONAL POLIOMYELITIS CONGRESS

The outstanding session of the third international poliomyelitis conference, held in Rome from September 6–10, was that devoted to infection and immunity. The hopes raised by the prospect of effective vaccination against the disease were in everybody's minds and the speakers at this session faced a crowded and expectant audience.

Infection and Immunity in Poliomyelitis

Problems of epidemiology—*Professor Pierre Lépine* of the Institut Pasteur in Paris reviewed many well known problems in the epidemiology of the disease; it was necessary that he should do so as a prelude to what came later. Even if we knew everything about the habitat of the virus and its mode of spread we should still be faced with the greatest mystery of all: namely how it is that so few people go down with the disease even though the virus may be harboured by a large

number. Lépine was doubtful whether the appearance of paralytic cases was due to a temporary exaltation of the virulence of the virus. He thought it probable that the quantity of virus was important and that the mode of contamination might be significant; the clinical disease might be caused by direct spread from one person to another via the respiratory tract whereas contamination via the digestive tract might do no more than produce immunity. However, there were circumstances in which the conditions and chances of contamination were the same for all yet only a few developed the disease. Thus there must be certain adventitious factors influencing susceptibility. Some were known, namely over-exertion, irritating injections and pregnancy. There might be others as yet undetermined. Yet it might be that such accidental events would not explain everything, and susceptibility might ultimately depend largely on a strictly intrinsic factor—a genetic inability to acquire immunity. However, even this hypothesis was shaky because the production of antibody by a subject recently stricken by poliomyelitis was in no way different from that in persons who had gradually acquired immunity without ever contracting the disease.

Immunity in different communities—*Dr J. H. S. Gear*, Director of Research in the South African Institute for Medical Research, Johannesburg, described the development of immunity in various types of population. An individual's past experience of infections was clearly imprinted on his blood. By surveys of the antibodies in sera from representative samples of a community it was possible to determine not only the nature of the infections that have smitten a population but also when they last occurred. The most useful information about poliomyelitis had come from isolated communities. It was found, for example, that among certain Eskimos infection with Type I virus had occurred in 1950, Type II about 1930 and Type III about 1915. The more crowded and primitive a community the greater the chance that immunity would develop to all three types at an early age. The pattern of immunity would surely determine the form taken by an epidemic. Where conditions were primitive and insanitary, immunity would be high and epidemics would be confined to infants. In island populations where immunity might be limited to one type of virus a severe epidemic affecting all ages might occur if another type of virus were introduced. In more advanced communities with a good standard of sanitation the natural exposure to immunising doses of virus was reduced; the age of exposure and therefore the development of immunity was much later than among primitive peoples. Thus among the sophisticated the disease was not limited to infants. Clearly the study of the effectiveness of any form of protection against the disease must be based on knowledge of the immunological state of the population concerned.

Gamma globulin—*Professor Hugo Muench*, Statistician in the Harvard School of Public Health, reported the results of the most extensive field studies so far carried out. Hitherto the only available positive protective measure had been the injection of gamma globulin and the source of supply was naturally limited. In 1953 mass tests were performed in twenty-three areas in the United States and it was now possible to assess the incidence of paralytic poliomyelitis in subjects who had received gamma globulin as compared with controls who had received an injection of gelatine. The data were difficult to analyse because immunity was brief, outbreaks were capricious and the attack-rate low. In general, gamma globulin had a definite protective effect and might even be of some use when given late in the incubation period as is usually the case with family contacts of a patient. However, it was necessary to apply statistical methods to reveal this, an indication that the protection was only partial.

Dr W. Hammon of the Graduate School of Public Health, University of Pittsburg, raised the question whether the injection of gamma globulin interfered with the natural development of immunity. An investigation involving no less than 3,000 pathological examinations showed that people exposed to poliomyelitis virus who had received gamma globulin became carriers of virus in the same way as those who had not received it. The immunological response was not inhibited but large doses of gamma globulin delayed it to some extent.

The development of a non-infectious vaccine—*Dr J. E. Salk* of the Department of Bacteriology, University of Pittsburg recalled that success in the control of poliomyelitis seemed to depend entirely on the development of an effective vaccine, and the question was whether the vaccine should be an attenuated live one, as used for protection against yellow fever, or whether a killed vaccine would suffice. The safety of the latter was self-evident, but a live vaccine was likely, on the face of it, to be the more effective. At first he and his colleagues had worked with both types; but, when they discovered that killed vaccines were capable of provoking a serological response like that following natural infection, they devoted all their efforts to the production of a non-infectious vaccine. The difficulty was to abolish infectivity without at the same time abolishing antigenicity. However, it was found that weak formalin reduced the first at a very much slower rate than the second. The preparation of the vaccine on a large scale was most complicated, and each batch has to be tested stringently for infectivity before clinical trial could be contemplated,

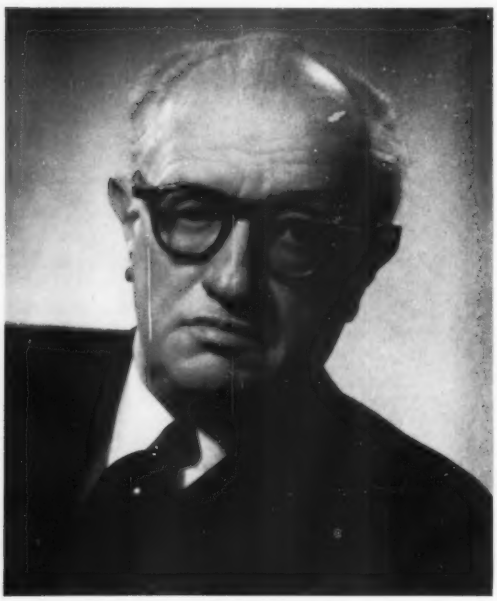
and it proved necessary to test each batch for the presence of B. virus and the virus of lymphocytic choriomeningitis, for bacterial sterility and antigenic potency. It finally became possible to sanction the inoculation of large numbers of subjects, and no less than 650,000 children had now received the Salk vaccine. The result could not be determined until after the epidemic season, but the final data were expected by April 1955. A favourable conclusion would be followed as rapidly as possible by the preparation of vast quantities of vaccine by the great commerical houses. A further point to be considered was the permanence of the immunological response. Dr Salk found that by proper spacing of the injections the level of antibody formation induced by the vaccine could be raised to a higher level than that generally observed after natural infection, so that artificially induced immunity promised to be as durable as that occurring naturally.

Live vaccine—*Dr Albert Sabin* of the University of Cincinnati had not been discouraged by these remarkable developments from continuing his search for an effective and safe live vaccine, believing that, as protection against yellow fever could be conferred harmlessly by an attenuated live virus there was no reason why the same thing should not be done in poliomyelitis. By passing the virus through a highly artificial culture medium up to thirty-three times, he was able to produce a strain which would not cause paralysis when injected into the brains of cynomologus monkeys. However, the strain produced some paralysis when injected into the spinal cord of these monkeys or of mice, but not in chimpanzees. The immunological response was, however, disappointing in that large quantities of the weakened virus were required to produce a significant effect.

INTERNATIONAL SOCIETY OF ORTHOPAEDIC SURGERY AND TRAUMATOLOGY

At the Sixth Congress, held in Berne during the period August 30 to September 3, 1954, Dr Jean Delchef of Brussels was elected President of the Society for the next three years in succession to Sir Harry Platt who has completed the longest statutory tenure of six years.

Dr Delchef was chosen as the first Secretary-General of the Society when it was launched in Paris in 1929, and from the beginning he placed at its disposal accommodation for its documents, and the services of his own secretary. Thus for a quarter of a century he has been the mainstay of SICOT; indeed, as Professor Bryan McFarland said at the meeting in Berne—"but for Dr Delchef the Society might well have died."



Dr Jean Delchef
Elected President of the International Society.

The archives of the Society now fill two rooms in Dr Delchef's house; and for him SICOT has been, as he has often said, "*une affaire de famille.*" Members of the International Committee will remember how the intimate atmosphere of its meetings has often been enhanced by the presence of Dr Delchef's young daughter and son mobilised for action—distributing ballot papers, writing on the blackboard, and making themselves generally useful!

Dr Delchef has close ties with orthopaedic surgeons in Great Britain, for he has attended many meetings of the British Orthopaedic Association of which he is one of our most popular foreign members. SICOT will thus have at its head a surgeon of high repute, a true internationalist, and one who has deservedly gained the esteem and affection of members of the many nations now represented in the Society.—H. P.

SIXTH CONGRESS, 1954

The Sixth Congress of the Société Internationale de Chirurgie Orthopédique et de Traumatologie (SICOT) was held in Berne from August 30 to September 3, 1954. The President of Honour of the Congress was Dr R. Scherb (Zurich); the President of the Congress was Dr Etienne Sorrel (Paris); and the Vice-President was Dr M. Dubois (Berne).

At the opening session of the International Society of Orthopaedic Surgery and Traumatology, Sir Harry Platt, President of the Society, being admitted Honorary Doctor of Medicine of the University of Berne by the Rector, M. P. Liver.

The opening session was honoured by the presence, among others, of M. Ph. Etter, Federal Councillor and head of the Department of the Interior, and M. P. Liver, Rector of the University of Berne, who admitted Sir Harry Platt, the President of the Society, to the Honorary Doctorate in Medicine of the University with this citation:

"Sir Harry Platt, Manchester, élève remarquable de Sir Robert Jones, a non seulement poursuivi l'oeuvre de son maître, mais encore lui a donné un essor considérable en prenant une part éminente au développemente de la chirurgie orthopédique anglo-saxonne. Celle-ci, grâce à cette collaboration importante, est devenue un édifice imposant dont la valeur est universellement reconnue. Sir Harry Platt a fourni un travail scientifique de haute portée internationale.

"Ses travaux chirurgicaux traîtent spécialement des lésions traumatiques des nerfs, des paralysies, des affections articulaires congénitales et acquises, des maladies des os. Ils sont ceux d'un maître qui s'est révélé aussi un parfait organisateur. Son oeuvre médico-sociale est des plus importantes.

"Il a pris une part active au développement de la médecine tant sur le plan biologique que social, développement indispensable dans un Etat moderne."

Scoliosis

Introduction—*Professor Bryan McFarland* (Liverpool) traced the history of scoliosis from Hippocrates through Galen, Paul of Aegeina, Paré, Glisson, Andry and others to such as Steindler and Cobb. Professor McFarland emphasised the importance of discovering the causes, which he thought might rest with a coincidence or a sequence of factors.

Prognosis and treatment of idiopathic scoliosis—*Mr J. I. P. James* (London) said that idiopathic or essential scoliosis was diagnosed by exclusion but had characteristics of its own distinguishing it from other forms—for instance from the scoliosis of poliomyelitis by the female preponderance, usually shorter curves, and absence of histological or other evidence of muscle change. It was unrelated to postural curves. In an infant, a single structural curve without secondary curves would always disappear spontaneously.

Curve patterns (Ponseti and James), taken with age, gave a means of prognosis. They were: 1) Lumbar; 2) Thoraco-lumbar; 3) Thoracic, (*a*) infantile, (*b*) juvenile, and (*c*) adolescent; 4) Combined lumbar and thoracic. In lumbar idiopathic scoliosis, which principally affected girls, the curve had its apex at L.1, 2 or rarely 3, might equally be right or left, and never became severe in degree or appearance but often caused backache which might require fusion. Thoraco-lumbar idiopathic scoliosis, with the apex at T.11 or 12, was generally more severe than the lumbar variety, and caused prominence of one hip and often backache; fusion was sometimes needed for either of these disabilities. Thoracic idiopathic scoliosis, with the apex between T.6 and T.10, affected girls

in 90 per cent of cases, was to the right in 90 per cent, usually began at about ten years, and was very deforming with distortion of ribs, dropping of one shoulder and prominence of a hip. The infantile variety started at 0–3 years, usually 1, occurred usually to the left (90 per cent) and usually in boys; the prognosis was bad. The juvenile variety, starting usually between five and seven, was more commonly to the right and in girls and had a bad prognosis. The adolescent variety, the commonest, might produce very great deformity in two years. Combined lumbar and idiopathic scoliosis had four curves, the middle two being primary; the outlook was good.

Treatment—Progress depended on the type of curve rather than upon any form of conservative treatment except possibly Blount's Milwaukee jacket, which Mr James had used for very severe scoliosis in children too young for operation. His indications for correction and operation in idiopathic scoliosis were: lumbar, probably never; thoraco-lumbar, occasionally for a prominent hip, with good results; infantile thoracic, usually at about ten years; juvenile thoracic, probably, if the curve were 65 degrees by the age of ten; adolescent thoracic, if the curve approached 70 degrees, especially in the younger patients; combined thoracic and lumbar, only the rare case with each curve greater than 100 degrees. Risser's observation that spinal growth, and therefore progressive deformity, ceased with completion of iliac apophyses was very valuable. Thoraco-lumbar and thoracic curves were corrected in the Risser jacket with head and arms free. In upper thoracic paralytic curves and combined lumbar and thoracic curves the Stagnara distracting jacket had been used, but at the price of sores. Through a window the spinous processes, laminae and transverse processes were decorticated and bone bank chips applied to a depth of ¾ inch and width of 1–1½ inches; and recently a notched fibular graft has been sprung in between the spinous processes above and below to prevent subsequent bending of the cancellous grafted area. Operation was in one stage, with blood transfusion of 4–5 pints. After six months, the child was allowed up in a plaster jacket.

Results in ninety-nine patients, who had had correction and fusion for all types of scoliosis, were reviewed after one to five years, and an average of two and a half years—a period that the speaker considered far too short for more than a preliminary report. The types of scoliosis were: idiopathic thoracic adolescent, twelve patients; idiopathic thoracic juvenile, ten; idiopathic thoracic infantile, twelve; idiopathic thoraco-lumbar, two; idiopathic combined, one; paralytic (poliomyelitis), forty; congenital, fifteen; in neurofibromatosis, five; other, two. The patients were all aged between ten and seventeen years, except three younger and fifteen older. During the second six months after operation, when the children were walking in their plasters, bending of the grafts led to loss of correction averaging 25 degrees in successful cases. Correction held in seventy-five cases amounted to: 50–64 degrees in nine; 40–49 degrees in ten; 30–39 degrees in eleven; 20–29 degrees in twenty-seven; 10–19 degrees in eighteen. The main cause of failure was pseudarthrosis, with or without sepsis. The curve was increased in only seven. Mr James considered that early correction and fusion, based on prognosis, was the most promising surgical approach to scoliosis.

Treatment of scoliosis—*Professor Oskar A. Stracker* (Vienna) considered principally the treatment of the developing progressive types. Although, after correction, various kinds of operation were done, a better understanding of etiology might make it possible to increase vertebral growth on the concave side or diminish it on the convex side by methods involving as little trauma as possible. *Dr Walter P. Blount* (Milwaukee) denied the futility of conservative treatment. Though asymmetrical exercises and conventional supports were harmful, frequent rest, symmetrical posture and breathing exercises and corseting the weak abdomen were helpful. The Milwaukee brace, which exerted both distraction and lateral pressure, would correct early paralytic scoliosis and reduce most paralytic curves by 10–15 degrees. The rapidly increasing curve needed fusion by operation, the brace being used for correction before operation and maintenance afterwards. In mobile curves the facets should be fused, and autogenous bone was used as much as possible. *Dr Marcel Fèvre* (Paris) found severe scoliosis less frequent in the last thirty years because of early treatment of slight vertebral deformities by simple gymnastics and minor apparatus. Congenital scoliosis with vertebral malformations was less sinister than had been supposed, and a single curve without vertebral malformations was often cured by a corrective plaster bed applied very early. Idiopathic scolioses were grave. If rest, exercises, diet, plaster beds and corsets did not hinder their progress, the question of surgical treatment arose. A massive autograft, though less modern than stored bone, remained an excellent method. *Dr J. J. Herbert* (Aix-les-Bains) advocated correction, operation in plaster, with homogenous cancellous grafts applied to the freshened spinous processes and laminae, and prolonged immobilisation. *Dr Rex Diveley* (Kansas City) illustrated a lateral traction apparatus that had helped correction if the primary curvature were thoracic and the ribs provided a purchase for traction. In scoliosis from a wedge-shaped vertebra, a reverse wedge was made by forcing the superior facet upwards on the lower and holding them by fusion and a bone block. *Dr Carlo Marino-Zuco* (Rome) advocated preparatory breathing

exercises with the patient prone on a special frame and operation in two or exceptionally three stages, with resection of the rib prominence, correction of the spinal curvature, fixation with special stainless steel plates and arthrodesis on the concavity or the convexity according to age. *Dr V. Novak* (Brno) favoured fixation of the spine with wire passed round the spinous processes, the thoracic transverse processes or the cervical neural arches. *Dr G. Roederer* (Paris) spoke of a special, severe, seemingly congenital scoliosis, usually high, commoner in boys, beginning at six or seven years, in which grafting was important. For ordinary essential scoliosis, exercises and appliances, including a special plaster bed at night, were not ineffective.

Simplified surgical treatment—*Dr Ivar Alvik* (Oslo) had tried in the last two years to simplify the operation and after-care, avoiding prolonged recumbency. After mobilisation of the curves by physiotherapy, a plaster was applied with the patient standing with correction by side traction to a vertical frame, and further correction might be obtained by wedging. After removal of the plaster, a long fusion with much bank bone was carried out at one session on the convexity alone in growing patients, the paravertebral part of the ribs being included. The patient was got up in the first week, and, as soon as he could stand for twenty minutes, a new corrective corset was applied as before, wedged if necessary, and retained for six to eight months.

Operative correction—*Mr F. G. Allan* (Birmingham) described a method that avoided plaster jackets, shortened the tedious correction to a few minutes and maintained it till consolidation was complete. This method could not be used for curves of less than 70 degrees, but the more severe the curvature, the more efficient the method. It was applicable to high curves difficult to correct otherwise. The concavity was opened out by a jack consisting of a turnbuckle with forked angled extremities, each of which engaged with the base of a transverse process where it joined the vertebral body. Through an incision in the line of the spinous processes, these and the laminae were exposed, and also the transverse processes and some ribs on the concave side. With head and leg traction, the closed jack engaged transverse processes at or just beyond the limits of the primary curve and the turnbuckle was extended till the greatest permissible correction had been obtained. The fusion operation with bone chips could proceed then, or after one or two weeks when further correction would prove possible. If the jack held firmly, patients sat up next day without external fixation; otherwise they lay a few weeks in a plaster shell. In eleven cases of scoliosis of various kinds, correction of the primary curve varied from 6 to 60 degrees. Correction of 20 degrees was achieved in a boy with congenital heart disease (Fallot's tetralogy) that had been improved by a Blalock's operation four years before. Two complications met had been mild ileus in two patients, two or three days after operation, and a small pneumothorax complicating rib resection in another.

Treatment by vertebral osteotomies—*Dr Pierre Bertrand* (Paris) had attempted to correct scoliosis by vertebral osteotomies, but these were still in the experimental stage and too few for assessment.

Scoliosis with paraplegia—*Dr F. Grospic* (Zagreb) had had five patients with paraplegia complicating scoliosis. Three recovered with laminectomy and division of the dura, and two died.

Therapeutic implications of the pathogenesis of idiopathic scoliosis—*Dr Aladár Farkas* (New York) supposed two types of idiopathic scoliosis: thoracic, with early compression due to juvenile osteoporosis; and lumbar, with early rotation from congenital anomalies of the neural arches. Thoracic scoliosis was harmed by exercises or forced correction, and not greatly helped by fusion of the neural arches. In lumbar scoliosis fusion seemed more hopeful, and the pain that specially characterised lumbar scoliosis might be relieved permanently by his method of the "fundamental position of rest."

Results of surgical treatment—*Dr N. Zinner* (Budapest) reviewed twenty-six scoliosis operations performed between 1946 and 1953 in patients between fifteen and twenty-two years old. After correction with plaster of paris jackets, a strong tibial graft was applied through a window under local analgesia. Walking was allowed in three or four weeks; fusion was said to be complete at three months; and appliances were abandoned after six months. All patients became free of complaints and able to work without appliances. Dr Zinner gave a preliminary report of experimental work in rats of placing a pushing spring on the concave side and a compressing spring on the convex.

Preparation for operation—*Dr O. Hnevkovsky* (Prague) had practised not only a very thorough history-taking and physical examination, but had included a complete examination of pulmonary function (Kvaček, J., Lenoch, F., Nechvátalová, L., Poláková, Z., Provazníková, J., Truhlář, P., and Zámostná, M. (1951): Acta Chirurgiae Orthopaedicae et Traumatologiae Čechoslovaca, **18,** 184) (English summary), muscle and functional tests. Examination was repeated every two or three months, and the response to exercise treatment assessed. Often after many months the physical condition would become stabilised, so that disturbed thoracic function no longer called for operation but only considerations of appearance.

The place of conservative treatment—*Dr Pierre Stagnara* (Lyons), observing that essential

scoliosis nearly always progresses during puberty (ten to fourteen years) and that most conservative treatments are ineffective, reported that in Professor Guilleminet's clinic correction by Donaldson and Anderson extension plasters and Abbott plasters had enabled this period to be passed without aggravation and sometimes with unquestionable improvement. Customary stabilisation at the age of sixteen or seventeen years released the patients from their plasters and daily exercises. *Dr André Trèves* (Paris) considered that nearly all scolioses called essential originated from a lumbo-sacral congenital deformity and that they often became painful after pregnancies and especially after the menopause. Individual daily remedial exercises were essential, and should be continued in adult life. A plaster bed made in the corrected position was useful. *Miss M. Forrester-Brown* (Edinburgh) stressed early diagnosis and the successful treatment of a lateral curve observed in the first few days or weeks of life with Schede bed, three-point pressure and anklet traction, walking being deferred till the curve was reversed. For the early detection of curves in poliomyelitis, children should be inspected weekly for six months, then monthly for years, and finally six-monthly till growth finished.

Incidence—*Dr Alfred R. Shands, Jun., and Harry B. Eisberg* (Wilmington) had examined 70 millimetre chest radiographs from a survey in Delaware. The incidence of scoliosis in the first 15,000 was:

Total number of cases of scoliosis		230,	15 per 1,000
Severity	Mild	184,	12 per 1,000
	Moderate	30,	2 per 1,000
	Severe	16,	1 per 1,000
Etiology	Postural	150	
	Idiopathic	61	
	Congenital	7	
	Thoracoplasty	6	
	Paralytic	6	
Type of curve	C	167	
	S	63	
Sex	Male	71	
	Female	159	

Surgery of the Hand

The second main subject of the congress was surgery of the hand.

Palliative operations for paralysis of the hand—*Professor R. Merle d'Aubigné* (Paris) reviewed the indications, technique and results of 145 palliative operations of tendon transfer. In radial palsy, tendon transfer was best, especially flexor carpi ulnaris to the finger extensors, palmaris longus to the thumb tendons, and pronator teres to extensor carpi radialis; one flexor must be left intact. For paralysis of opposition of the thumb, Bunnell's transplant of the flexor sublimis of the ring finger seemed best. The sublimis tendons could be used also for paralysed intrinsics. Transfer was less useful for long finger flexors. Electromyography helped the selection of sound muscles, and had shown that the synergic actions present before transplantation did not disappear after transplantations, and that new ones were created.

Treatment of fresh tendon injuries in hand and fingers—*Dr Jörg Böhler* (Linz), recalling that the initial treatment often determined the fate of the hand, stressed the great demands made on the capacity and time of the surgeon, and the need for good organisation with undivided and continuing responsibility. He emphasised the technical importance of a pneumatic tourniquet, economy of excision, and correctly placed incisions, and of avoiding simultaneous skin-grafting and tendon repairs. Digital nerves should be sutured by a meticulous technique, not synchronously with tendons. Accurate reduction of fractures was maintained with transfixion wires if necessary. The profundus tendon was sutured if divided distal to sublimis, otherwise not. Division of both flexor tendons in the unfavourable area was treated by delayed tendon grafts of palmaris longus with its paratenon by Bunnell's technique. Proximal to the tendon sheaths suture was performed, with excision of sublimis unless proximal to the flexor retinaculum [transverse carpal ligament]. Hyperextension of the interphalangeal joint for recent mallet finger was maintained by transfixion with crossed wires, unless a large bony avulsion allowed suture.

Reconstruction of the thumb—*Dr J. Gosset* (Paris) discussed methods and gave a superb motion picture display of pollicisation of the index and even the middle finger (Hilgenfeld). Both technique (described in Journal de Chirurgie, 1949, **65,** 403) and results were impressive.

The severely crushed hand—*Dr Michael L. Mason and Dr John L. Bell* (Chicago) outlined the first aid and primary operative treatment of the crushed hand. Excision should be adequate but no more. Nerves should be repaired, but seldom tendons. Closure by suture, skin grafts, flaps

or a combination of these was essential. In splinting, the hand should be moulded to a suitable shape. Necessary secondary procedures were carried out soon after healing.

Reparative surgery of flexor tendon injuries in the hand—*Mr R. Guy Pulvertaft* (Derby) advocated primary flexor tendon repair only with reasonably clean incised wounds—without severe skin, bone or joint damage—treated within usually six hours under proper conditions by a surgeon of appropriate experience. Good results could be obtained in division of flexor digitorum profundus beyond the sublimis attachment, in distal division of flexor pollicis longus, in palmar divisions or in divisions at wrist level. Cases of division of flexor digitorum sublimis and profundus between the distal palmar crease and the sublimis insertion should be left for secondary tendon grafting, which would place suture lines where adhesion did not matter. In secondary repair, severe scarring, stiff joints or divided digital nerves needed prior attention. Gentleness, a bloodless field with removal of the pneumatic tourniquet and strict haemostasis before the end of the operation, and suitable suture materials were imperative. Tendons preferred as grafts were a long extensor of a toe, palmaris longus or plantaris. Grafts were tethered distally through a transverse tunnel in the terminal phalanx or by a Bunnell withdrawal suture, and proximally to flexor profundus by a special interlacing suture. The tension of a graft should be rather greater than the position of the other fingers would suggest to be correct, as the contracted muscle belly would lengthen later. Active gentle movements were allowed in four or five days, except in children or uncertain cases. Improvement ceasing after three or four months might sometimes be improved remarkably by tenolysis without any interposition of glide material.

Surgical technique of free grafting of tendons—*Dr Erik Moberg* (Göteborg) showed in detail, with a superb colour film, the technical details of excision of scar, preparation of bed, taking of tendon grafts, their application, and the results of treatment.

Free skin grafts in the treatment of contused wounds of the hand with important loss of substance—*Dr M. G. Annovazzi and Dr Pagano Gianni* (Milan) advocated early specialist treatment and care of the circulation with a view to first-intention healing and, if necessary, secondary interventions.

Treatment of stiff digits—*Dr Raoul Tubiana* (Paris), who recalled that stiffness could often be prevented by careful primary treatment, favoured capsulectomy for the metacarpo-phalangeal joints if the coverings were supple, the muscles active, and deformities absent. Similar operations on the interphalangeal joints gave indifferent results because the lateral ligaments had to be divided, and arthrodesis in good functional position was usually better. Re-education, by active movements, was essential before and after mobilising operations. Various examples of elastic apparatus were depicted. Intra-articular hydrocortone occasionally helped.

Reconstruction of lost fingers, and free grafts of hand tendons—*Dr Josef Ender* (Vienna) showed a motion picture of various treatments for restoring function to crippled hands and the results—formation of a cleft hand after loss of all fingers, reconstruction of the thumb by a tibial graft and abdominal tube pedicle, transplantation of the third finger for loss of the thumb, and formation of a new finger by a tibial graft and a skin graft. The results were shown also of free tendon grafting for severed flexor tendons. All the results shown were very good.

Influences on prognosis—*Dr J. H. Boyes* (Los Angeles), who demonstrated a clear and accurate method of assessing the results of flexor tendon grafting, had analysed the restoration of active and passive movement after secondary procedures in 300 cases of finger injury, and had concluded that the chief influences were technique and the condition of the tissues, for instance scarring and stiffness.

Anatomy of infection of the finger pulp, and its treatment—*Dr M. Belenger and Dr E. Van der Elst* (Brussels) had studied the terminal phalanx of the finger anatomically, and confirmed the usual view about the vascular supply. In pulp infection, incision should be delayed till the patient has had a sleepless night and should involve excision of the necrotic area, with plaster fixation, elevation and administration of antibiotics.

Pathological considerations and results of treatment of Dupuytren's contracture—*Dr Enzo De Marchi* (Venice) discussed the results of forty-nine cases treated by operation and ten conservatively. He regarded the condition as a collagen disease and stressed the importance of adapting treatment to the state of progress, subcutaneous fasciotomy being reserved for the very severe.

Palmaris longus pain syndrome—*Dr Steele F. Stewart* (Honolulu) spoke of a boy of fifteen, who, when drumming, would lose the use of his hand because of pain in the wrist; on active flexion a swelling would bulge proximal to the flexor retinaculum [transverse carpal ligament]. On exploration, a year later, the bulge proved to be a muscle belly, continuous distally with the palmar fascia and emerging proximally from beneath the deep fascia of the forearm. The aberrant muscle was resected because it possibly compressed tendons and nerves on contracting. The symptoms

disappeared. The position of the muscle strongly suggested that it was a peripheral belly of palmaris longus, which sometimes showed vagaries in the position of its belly and even multiple bellies.

Carpal tunnel compression—*Mr K. I. Nissen* (London) described and illustrated the massive, almost acellular, hypertrophy of the synovial tendon sheaths that may be found in cases of otherwise unexplained carpal tunnel compression.

Operative treatment of manus vara and manus valga—*Dr N. Zinner* (Budapest) had transplanted one end of a fibula, with its intact epiphysial plate, to replace the missing distal third of the ulna. Growth took place at the transplanted plate and was continuing after four years. In another patient, traumatic manus valga had been corrected by replacing the destroyed lower end of the radius by the ulna and fusing the wrist.

Posture and Muscle Action

Dynamic posture or posture in action—*Dr Beckett Howorth* (Stanford) discussed favourable postures and correct use of the body in relation to work, games, and such simple daily activities as rising from a chair. Poor dynamic posture favoured fatigue, accidents and such degenerative diseases as osteoarthritis. Orthopaedic surgeons should be able to advise on the most effective and safe use of the body.

Defective posture in children before and at school age in relation to respiratory trouble—*Dr J. Janek* (Brno) stated that expert ear, nose and throat examination of 1,520 children with thoracic kyphosis or early scoliosis, without evidence of spinal disease, revealed respiratory trouble in 1,062, nearly 70 per cent. He concluded that treatment should be first early removal of respiratory obstructions and then proper orthopaedic treatment.

Antagonism between semimembranosus and semitendinosus muscles in man—*Dr J. E. Enklaar* (Amsterdam) discussed the differing actions of the medial hamstring muscles—which depended on the different relations of their attachments to the axes of hip and knee—in terms of mathematical formulae related to a "quadrangle of articulated bars" represented by the femur, the tibial condyle, the ischium and the muscle.

Growth, Repair and Grafting of Tissues

Bone growth and bone repair studied with radio-active isotopes—*Dr Göran S. H. Bauer and Dr N. Sophus von Rosen* (Malmö) recalled the prevalent opinion that rapid equilibrium between the bone salts and body fluids prevented a computation of new bone salt formation with labelled bone seekers such as Ca^{45}, P^{32} and Sr^{89}. On the other hand it had recently been shown that bone salt, once deposited in the organic matrix of the skeleton was little available for the supposed exchange, so that it had been possible to determine the rate of deposition in the bones of normal rats and of those with fractures.

Grafting of refrigerated bone and cartilage in joint surgery—*Dr Walter Ehalt* (Graz) had found that cartilage cells in osteochondral fragments from human joints died after four or five weeks in the "bone bank." In rabbits, parts of joints refrigerated for various durations were successfully grafted. Consequently, bone with its cartilage covering, refrigerated for several weeks, was used: 1) to replace an excised tuberculous focus in the lower femoral epiphysis in a boy of five, and 2) to replace the joint surface of one patella in a woman of twenty-seven with bilateral patellar chondropathy. Union occurred and a good functional result was reported in each. The method was suggested also in osteochondritis dissecans and in post-traumatic osteoarthritis.

The use of preserved skin in orthopaedic surgery—*Dr V. Sanchis Olmos* (Madrid) had begun in 1952 to use human skin, removed immediately after death and preserved in a merthiolate solution, for interposition in arthroplasty of the elbow and in arthroplastic reduction of a congenital dislocation of the hip, and for reinforcing tendons as in filling the gap after excision of the patella.

Plethysmographic and capillaroscopic researches in the evolution of free skin grafts—*Dr J. Annovazzi and Dr Pagano Gianni* (Milan) had investigated the circulation in free skin grafts with the plethysmograph and the capillary microscope. There was no indication of a circulation at twenty-four hours, but considerable return after four days, more at eleven days, and a normal circulation at a year.

Congenital Dislocation of the Hip

Geographical distribution and racial influence on congenital dislocation of the hip—*Professor C. Casuccio* (Bari) refuted the supposition that congenital dislocation of the hip is less common in southern Italy than in areas peopled by the alpine race.

Etiology of congenital club foot and of congenital dislocation of the hip—*Dr. K Jdelberger* (Giessen) from work upon twins, including his own examination of 242 unselected pairs, concluded that neither club foot nor congenital dislocation of the hip was commoner in twins.

Treatment of congenital dislocation of the hip by means of the abduction pillow—*Dr B. Frejka* (Brno) asserted that ordinary conservative treatment of congenital dislocation of the hip leads to necrosis of the head in 20–50 per cent. Since 1946 he had treated all patients of three years and under with the abduction pillow, originally introduced for prevention. If there were no anatomical obstruction, reposition took place spontaneously, and a leather splint was used to hold the hip flexed 80 degrees and abducted 70 degrees till radiographs showed an adequate upper part of the acetabulum. If the abduction pillow failed, open operation was performed, in the second or third year, to deal with the obstruction—adhesion of capsule to socket or to ilium—or with anteversion.

Causes of " epiphysitis " in congenital dislocation of the hip, and prevention by early operation—*Dr Jean Judet* (Paris) had followed radiographically, for ten to thirty years, fifty patients with reduced congenital dislocation. Those complicated by epiphysitis showed marked deformity of the head, cervical thickening and coxa vara. Without this complication, evolution depended entirely upon mechanical factors, which might be disturbed by 1) a fibrous interposition, preventing reduction, 2) aplasia of the roof, and 3) incongruity, from a large head or from anteversion. Operations to correct either an aplastic (oblique) roof or anteversion should not be shirked, and should be done early, six months or a year after the end of other orthopaedic treatment.

Treatment of congenital dislocation of the hip—*Professor Domingos Define* (São Paulo) presented a film showing manipulative reduction at two years, a shelf operation at thirteen, and concurrent open reduction and shelf operation at thirteen for anterior dislocation.

Results of treatment of congenital dislocation in the young child—*Dr P. Bertrand* (Paris) *and Dr H. Guias* (Pont-l'Abbé) gave statistics from the centre at Pont-l'Abbé, which they considered to show the worth of arthrography, that open operation is almost always indicated in true dislocation, and that subluxations often call for conservative treatment, giving better results the younger the child.

Provisional results of intertrochanteric oblique osteotomy in congenital dislocation of the hip—*Dr C. Mau* (Hamburg) advocated intertrochanteric oblique osteotomy when anteversion and coxa valga favoured dislocating coxa valga and consequent arthrosis deformans. Operation was best performed at three or four years of age, eight weeks after the head had been brought low in the acetabulum by abduction and medial rotation; the bones were fixed with screws. Osteotomy could be supplemented by a subsequent shelf operation. The results were illustrated and so satisfactory that the speaker advocated a wider practice.

Other Surgery of the Hip

Slipping of the upper femoral epiphysis, early diagnosis and treatment—*Dr Beckett Howorth* (Stanford) emphasised the early symptoms, signs and radiology, and the great importance of early diagnosis. He described his operation of transfixing the epiphysial plate with bone pegs, an operation that had been performed more than two hundred times in his series, and gave the results. In about 150 cases with less than ¼ inch slip, there was no pain, limp, restriction of movement or disability for games. In about fifty cases with ¼–½ inch slip, there was no pain, little or no limp, slight limitation of medial rotation and abduction, and little or no disability. There were four technical failures; in three, the surgeons had not crossed the epiphysial plates with the pegs; and, in one, the pegs had been absorbed, probably from breakage at insertion; all four operations were repeated successfully.

Experience of hip arthroplasties by acrylic prostheses since 1946—*Dr Robert Judet* (Paris), who had now performed 1,000 hip arthroplasties, the first in 1946, reviewed two series of vicariously selected cases of operation in 1949 and in 1951.

Year	Number of patients	Died or untraced	Number studied in 1954	Very good	Good	Poor
1949	100	17	83	40	31	12
1951	100	16	84	38	29	17

Twenty-one patients operated on in 1951 considered improvement very slight; 67–71 per cent of patients were satisfied; 72 per cent had satisfactory radiographs, which usually went with good results. Late complications included: 1) atrophy of the neck and widening of the canal (slight widening was unimportant), for which he blamed circulatory interference at the operation and weight bearing, which now he delayed till the third month; 2) necrosis of the acetabulum, mainly due to incongruity with the head; 3) alterations in the prosthesis—breaking in two out of 800 cases since the prosthesis was reinforced.

The use of compatible materials in arthroplasty of the hip—*Mr A. N. Birkett* (Nottingham) had carried out twenty-eight arthroplasties of the hip, lining the acetabulum with a stainless steel

cup and replacing the femoral head by acrylic. The range of movement commonly obtained was: flexion 80–90 degrees, extension limited by about 9 degrees, full rotation, and some limitation of abduction and adduction. Useful movement was retained for at least five years, but did not increase after two and a half years. There was no evidence of pressure necrosis of the acetabulum. The acrylic prostheses were all loose after twelve months, but one examined at six years showed little wear. Experiments carried out in conjunction with the Department of Engineering of Nottingham University had shown very little wear in a model subjected to movement and intermittent loading in imitation of a walk of 480 miles.

Osteoplasty of the hip—*Dr Ugo Camera* (Turin) described an operation complementary to the radical treatment of osteoarthritis of the hip, namely " biological arthroplasty " by subchondral hollowing of the joint components and stuffing them with cancellous bone.

Stabilisation of the hip by a technique of central dislocation—*Mr John Charnley* (Manchester) ascribed the recent popularity of arthroplasty of the hip to the frequent stiffening of the knee after arthrodesis of the hip in the elderly. He described an operation for central dislocation of the shaped femoral head, which he had performed, with or without spring compression, in 120 patients during six years. The average stay in hospital was eight weeks. All were relieved of pain, although bony ankylosis failed in about 50 per cent, so that he now preferred the term stabilisation to arthrodesis.

Osteoarthrosis

Osteoarthritis of the hip and its pathology—*Professor J. Trueta* (Oxford) had observed that the first changes were always in the non-weight-bearing parts of the cartilage. Here there was later invasion by new bone, whereas the weight-bearing area suffered changes leading towards eburnation. Proliferation of vascular channels caused hyperaemia, as witness great vascularity at operation and a temperature in osteoarthritic hips averaging about 5 degrees centigrade above that of normal hips. If the pain were due to the hyperaemia, the possibility of diminishing this should be considered.

A contribution to ochronotic osteoarthrosis—*Dr Jan Cervenansky and Dr S. Sitaj* (Bratislava) found the rare familial condition of alkaptonuria in as many as ninety-five patients in Slovakia, where in 1775 Joseph Singer of the University in Trnava described the " morbo nigro." Twenty-five of the patients had ochronotic osteoarthrosis. Excellent colour films depicted the occular brown pigment and the bluish discolouration of the auricular cartilages and of the nails. The spinal deformity in an advanced case was shown, with radiographs illustrating lipping and narrowing of major joints, especially those of the spine, whose intervertebral discs displayed radio-opaque areas. Colour films of biopsy of joints demonstrated the discolouration of articular cartilages and of some periarticular tissues, such as the ligamentum patellae.

Ankylosing Spondylitis

Treatment of ankylosing spondylitis with Thorium-X—*Dr Rudolph Wilde and Dr C. Mau* (Hamburg) had treated more than 100 patients in five years by injections twice weekly of thorium-X up to about thirty injections or 6,000 units. With due safeguards, there were no untoward reactions. The first relief was of pain, which was complete, and all patients had returned to work, most to sport. *Dr J. Kastert* (Stettin) *and Dr E. Güntz* (Frankfurt) had not exceeded twelve injections, or 14,000 units. Of 297 patients treated, 104 had been followed up; sixty (57·6 per cent) were " permanently " relieved of pain and thirty-eight (36·6 per cent) were improved. There was no, or only a transient, effect in 5·8 per cent.

Osteotomy of the spine—*Dr Jan Cervenansky* (Bratislava) showed good results from lumbar osteotomy by resection of neural arches.

Bone and Joint Tuberculosis

Early surgical treatment of bone and joint tuberculosis—*Dr Ed. Etienne* (Montpellier) had, for four years, combined curettage with local and general streptomycin in all cases of extra-articular tuberculosis at hip, knee or ankle, and the disease had always become arrested. Lately he had extended the treatment to cases of bone infection with joint involvement; the bone healed just the same but it was too soon to say what would happen to the joints.

Treatment of bone and joint tuberculosis—*Dr J. Debeyre and Dr S. de Sèze* (Paris) showed a film of open curettage of the spinal tuberculous focus, followed by closure and the instillation of antibiotics through a fine tube introduced through an independent stab. Sometimes antibiotics were introduced through a needle percutaneously without opening the focus.

Bone tuberculosis of the cystic type—*Dr Alexander Aimes* (Montpellier) exemplified the diagnostic difficulties of distinguishing this condition from the ordinary simple bone cyst and from fibrous dysplasia.

A lesion simulating tuberculous disease of the spine in children—*Mr Dillwyn Evans* (Cardiff) said that the antibiotics had made the accurate diagnosis of tuberculous lesions less leisurely; formerly, diagnosis was often established during treatment. When biopsy was impossible or inadvisable, fictitious therapeutic triumphs might occur. In children, a disorder characterised by lumbar pain and rigidity with narrowing of an intervertebral space, involvement of adjacent intervertebral bodies, and with a course usually afebrile, but perhaps mild leucocytosis and negative Mantoux test, might have a self-limiting course. Mr Evans thought such cases were non-tuberculous, possibly pyogenic. A motion picture of an example was shown.

Lymphangioma of the ankle simulating tuberculosis—*Professor Dimitrije Jovcić and Dr I. Stojimirović* (Belgrade). In the authors' experience angiomas were rare at the ankle, difficult to diagnose, and sometimes mistaken for tuberculous arthritis of the ankle, or vice versa. The appearance of the skin and sometimes radiology might help. Extirpation was indicated.

Ruptured Cruciate Ligaments

Rupture of anterior cruciate ligament—*Mr I. S. Smillie* (Dundee) had recorded the state of the anterior cruciate ligament in 1,000 meniscectomies, and he discussed the incidence, mechanism and significance of the common rupture encountered incidentally in meniscus injuries. It was found in 169 of 659 cases of medial meniscus injury, thirty-eight of 321 cases of lateral meniscus injury and eight cases of injury to both menisci. Some ruptures were caused by forced extension with prevention of the rotation which should accompany it. Most were caused by forced extension of a knee locked by intercondylar displacement of part of a split meniscus. It was caused by rapid movement as at football and not by the slower movement customary in miners, who presented only twenty-seven meniscectomies among 256.

Repair of cruciate ligaments by a meniscus—*Professor K. Niederecker* (Würzburg) showed a motion picture of an operation for repair of the cruciate ligaments performed in 179 cases. The medial meniscus was mobilised anteriorly, dislocated into the intercondylar notch and sutured to the remains of the cruciate ligaments. The anterior horn was passed forwards through a canal made in the tibial plateau and sutured to the periosteum. The results shown suggested that this operation shared the defects of its predecessors.

Late results of an extra-articular plastic operation in a case of very marked " signe de tiroir "—*Dr Akif Chakir Chakar* (Istanbul) described a case of very pronounced post-traumatic antero-posterior mobility of the knee relieved by Hans Hast's extra-articular plastic operation with fascia lata. Lateral instability was not relieved, but a second operation abolished it. With re-education, a result was obtained that was still excellent five years later.

Other Problems of Injury

Natural remodelling after fractures of the lower end of the humerus—*Mr F. W. Holdsworth* (Sheffield) held that the object of fracture treatment was to restore full function and good appearance. This did not always imply perfect anatomical position. Repeatedly attempted closed reduction was often advised in fractures of the lower end of the humerus although good reduction was often impossible without operation, which itself often gave poor functional results. Fractures of the lower end of the humerus were of five types: 1) true supracondylar fractures, 2) transcondylar fractures, 3) comminuted fractures involving the elbow, 4) separation of the capitulum, 5) separation of the medial epicondylar epiphysis. A follow-up of sixty-five patients, all over three years old and with much displacement, showed that in the first three groups full function did not depend upon anatomical reduction, the humerus becoming remodelled in the course of time. Lateral tilt was more important than antero-posterior or lateral displacement or rotation.

Unresolved problems of treatment of fractures of the femoral neck—*Dr R. Wanke* (Kiel) reported twelve cases of pseudarthrosis and necrosis in the first hundred of 110 cases of fractured neck of the femur treated by a Küntscher nail inserted more vertically than the usual cervical nail.

Traumatological problems in psychiatry and geriatrics—*Dr S. Tenoff and Dr D. Dezzani* (Turin) emphasised that the severe limitations imposed on treatment of injuries in restless or dirty patients, or in severe epileptics, did not apply to the less mentally ill, who must not be immobilised and must be got up early.

Tumours and Dysplasias

Tumours of the cartilaginous series—*Professor José Valls, Dr Fritz Schajowicz and Dr Jorge E. Valls* (Buenos Aires) recalled that in recent years there had been added to the series: epiphysial chondroblastoma, chondro-myxoid fibroma, periosteal chondroma and ossifying chondroblastoma. Cytological and pathological characteristics had been sought that might allow the distinction

between malignant and benign and define the cytological changes preceding, or implying, the frequent malignant transformation. The 165 cases studied were classified as shown.

Benign

Solitary		*Multiple*	
Chondroma or enchondroma	46	Multiple chondroma	5
Periosteal chondroma	6	Ollier's dyschondroplasia	2
Ossifying chondroma	3	Multiple osteochondromatosis	4
Epiphysial chondroblastoma	8	Articular osteochondromatosis	15
Fibro-chondro-myxoma	1		
Osteochondroma	45		

Malignant

Chondrosarcomas

Primary (central or peripheral)	19
Secondary (central or peripheral)	8
Chondro-osteogenic sarcoma	3

Tumours localised to broad or flat bones, even if presenting benign histological characters, and chondrosarcomas should be treated by major resection, or amputation if the soft tissues were invaded. Chondro-osteogenic sarcoma had an outlook like that of sclerosing osteogenic sarcoma.

Osteogenic sarcoma—*Dr Mark B. Coventry and Dr David C. Dahlin* (Rochester, Minnesota) had classified pathologically the four hundred cases of osteogenic sarcoma seen at the Mayo Clinic from 1909 to 1953 inclusive (during which there were seen also about two hundred chondrosarcomas, fifty fibrosarcomas, fifty reticulum-cell sarcomas and one hundred Ewing's tumours). Osteogenic sarcoma, defined as a malignant tumour of bone whose neoplastic cells form osteoid, might be predominantly osteoblastic (49·7 per cent), chondroblastic (26·8 per cent) or fibroblastic (23·5 per cent). Commonest in long bones, 60 per cent were about the knee. The percentage in each histological grade was: grade 1, 4·5 per cent (principally parosteal tumours); grade 2, 16·5 per cent; grade 3, 53·5 per cent; and grade 4, 25·5 per cent. Nearly half the patients were aged nine to nineteen years, and 62·8 per cent were male. Ninety-six per cent were traced. Survival (18·3 per cent for five years, and 14·3 per cent for ten) depended principally upon site: tibial growths were about two-and-a-half times as favourable as femoral, and pelvic growths had proved invariably fatal. Survival rates at five years for types and for grades were: osteoblastic, 15·7 per cent; chondroblastic, 22·0 per cent; fibroblastic, 20 per cent; grades 1 and 2 (excepting parosteal sarcomas), 21·6 per cent; grades 3 and 4, 17·7 per cent.

Treatment of innocent nerve tumours by enucleation—*Mr H. J. Seddon* (London) said that the schwannoma or neurilemmoma, the commonest isolated tumour of peripheral nerves, was infrequently diagnosed clinically because it rarely, if ever, interrupted conduction. Because it involved the whole thickness of the nerve, it was commonly treated by total excision, with consequent loss of function, sometimes severe. It was innocent, had a thin capsule and displaced the nerve bundles without invading them, so that the correct treatment was enucleation.

Treatment of localised fibrous osteitis—*Dr D. Logroscino* (Bari) advocated excision of the fibrous tissue, preferably with bone grafting; conservative treatment would lead to slow union, but would not modify the fibrosis. These points were illustrated by three cases.

Replacement of bone by internal prostheses—*Mr H. Jackson Burrows* (London) made an interim report on an experiment in conservative surgery carried out by members of the staff of the Institute of Orthopaedics of London University and the Royal National Orthopaedic Hospital. Patients with major replacement of bone by inert internal prostheses had been kept under observation for more than three years. They included: 1) *two cases of fibrous dysplasia* with severe disintegration of the skeleton of the lower limb, in which an amputation at the hip joint has been avoided by dividing the soft tissues at the junction of middle and lower thirds of the thigh, removing the whole femur and replacing its proximal part by an internal prosthesis; after five years and after three and a half years the patients were using their artificial limbs and were at full work; 2) *two cases of chondrosarcoma*, of the humerus and femur respectively, in which the tumour has been resected extraperiosteally with more than half the bone and replaced by a prosthesis, the distal part of the limb being preserved; after four years and a quarter, and after three years the patients were at full work; except for some stiffness and weakness of the shoulder of the first patient, function was almost full, with good power and no loss of length. One patient with amputation through the femur had required reamputation because the end of the prosthesis ulcerated through the stump. Radio-opaque fluid introduced into the hip joint outlined the whole

prosthesis and drained from the ulcer. The fibrous sleeve enclosing the prosthesis presented a smooth synovium-like lining. In cases without amputation, trouble might lie ahead from insecurity of the junction between prosthesis and bone; this problem was being studied experimentally by Dr J. T. Scales. With due attention to mechanical principles, acrylic had proved satisfactory so far; time might show that metal would be better, though heavier and more difficult to work.

Operations in Foot Deformities

A new approach to the treatment of pes cavus—*Mr F. C. Dwyer and Professor Bryan McFarland* (Liverpool) had observed that varus deformity of the calcaneum greatly accelerated the progress of pes cavus, and advocated correction of the varus by lateral wedge osteotomy of the calcaneum, without interference with the subtalar joint. The operation had been performed on twenty-three feet in seventeen patients aged three to fifteen years, and lantern slides of good results were shown.

Deformity of the talus in inveterate talipes equinus as an obstacle in operative treatment—*Dr W. Dega* (Pognan) had observed that prolonged talipes equinus in the child, whatever the cause, led to lengthening and plantar flexion of the neck of the talus, frontal wedge osteotomy of which was a necessary supplement to routine operative measures. The technique and excellent results were illustrated.

Arthrodesis of the foot—*Professor A. Sonnenschein* (Vienna) *and Professor Georg Hohmann* (Munich) advocated, especially for panarthrodesis, that resection of the joints should be supplemented by a specially shaped tibial graft, having its pointed end driven into the navicular bone and its body embedded in a tibial excavation.

Detachment of gastrocnemii in the operative treatment of spastic talipes equinus—*Professor O. Scaglietti* (Florence) recalled the deformities caused by misapplied tenotomy of the tendo achillis in spastic paralysis. Separation of the origins of gastrocnemius might correct simultaneously spastic pes equinus and knee flexion. A modification of Silferskiöld's method was shown by motion picture. Excellent results were shown.

Other Therapeutic Problems and Methods

Some problems of leg-lengthening—*Mr E. Goronwy Thomas* (Liverpool) dealt with stiffness of the ankle and foot, which he had observed after fifteen to eighteen otherwise uncomplicated operations performed six years ago. Demonstrable causes were: 1) tightness of soft tissues, 2) compression atrophy of the articular cartilage of ankle and tarsus, 3) secondary bony deformity, especially of the talus, and 4) failure of the fibula to lengthen in conformity with the tibia.

A simplified " Putti-Platt " procedure for recurrent dislocation of the shoulder—*Dr Ernest Brav* (Washington) had, in the last forty-five of seventy-five operations, omitted to suture the severed subscapularis tendon to the paraglenoid tissues, without evident loss of efficiency. In the whole series, there was recurrence in three of forty-one patients followed for two years.

Indications for surgical treatment in Klippel-Feil syndrome—*Dr A. Bonola* (Bologna) thought that surgical efforts should be made to improve function and appearance. Skin operations were occasionally possible for webbing between neck and shoulder. Muscle operations might correct contractures of the sternomastoid and other muscles complicating the bony deformity. Neurological operations were occasionally performed. Bone operations had been directed to lowering the scapulae, which could improve shoulder movements. In a severe case with fusion of all cervical vertebrae Dr Bonola had lengthened the neck by cervicalisation of the first three thoracic vertebrae by a thoracoplasty in which the uppermost three ribs of each side were removed. Lantern slides showed a most striking improvement in appearance, and improved mobility of the shoulders was reported.

A review of cervical disc problems—*Mr H. Osmond-Clarke* (London) distinguished acute cases—whether lateral with root symptoms and cervical kyphosis, usually responding to conservative treatment, or central, with cord compression requiring urgent operation—from chronic cases of " cervical spondylosis." The secondary osteoarthritis, fibrotic and vascular changes were mentioned. The clinical and differential diagnoses were discussed. Treatment by heat and intermittent head traction would relieve about two-thirds of early cases; a manipulation under anaesthesia would occasionally help but should never be used if radiological changes were great. These measures, or bed rest with continuous traction, would relieve 95 per cent of sufferers. If these failed or if a collar gave only temporary relief, local arthrodesis was required. In cases of cord or root compression, neurosurgical decompression should be followed by arthrodesis; neurosurgeon and orthopaedic surgeon should collaborate.

Table extension treatment of the lumbar spine—*Drs Th. Wyss and J. Ammann* (Zurich) demonstrated a table by which spinal traction could be combined with rotation and localised

pressure. Relief from lumbar disc disturbance was obtained in thirty-seven cases, slight improvement in three, and none in seven.

Delayed osteotomies—*Dr Oscar R. Marottoli* (Rosario) gave his favourable experience with osteotomy-osteoclasis described by John R. Moore of Philadelphia in 1947, which overcame simply, without osteosynthesis, such drawbacks as extensive plaster, prolonged immobilisation, delayed consolidation, and especially secondary displacements.

Hydrocortone (compound F) inoculation after arthrotomy—*Dr James E. M. Thomson* (Lincoln, Nebraska) and his associates had injected 1 or 2 cc. of hydrocortone into major joints after arthrotomies for injury or mechanical defect, and had made comparisons with controls. The injection did not appear to influence healing; it greatly diminished pain and so aided early movement, but did not shorten convalescence.

Symposia at Swiss Centres

Members were given the choice of visiting one of five Swiss centres or groups of centres—Basle, Berne/Macolin, Lausanne/Leysin, Geneva, and Zurich—at which symposia were presented and the visitors were handsomely entertained.

Orthopaedic and traumatological problems in gerontology—*Dr A. Vischer* (Bâle) discussed the problems, aims and limitations of gerontology, which ought not to become a special branch but rather inform all branches. The study of old age started at the beginning of life, and did not concern doctors alone. Our knowledge of the concurrent physiological and pathological changes in the involutional stage of life was inadequate. At present the expectation of life of a man was sixty-eight years, and of a woman seventy-one; patients over sixty represented 30 per cent of the hospital population; pensioners of the French State Railways exceeded the workers. The expectation of life of a patient of sixty-five now made long-term planning worth while. Professor Vischer referred to such problems in the aged as the determination of physiological and pathological elements in osteoarthritis, or in spinal osteoporosis, the vascular factor in painful feet after fifty years of age and the proper amount of exercise for ageing muscles.

Professor Rudolph Nissen (Bâle) discussed the special management of operations upon elderly people from the point of view of causes of death. First came bronchopneumonia and the need for breathing exercises. Second came thromboses and emboli, the foundations for which were laid in the first twenty-four hours; mechanical methods for prevention, including early rising, were of little value; anticoagulants appeared to be suitable in the elderly, though customarily withheld. The third cause of death was cardiac insufficiency; operation would be avoided if possible if there were old myocardial infarction, aortic stenosis and syphilitic aortitis, and digitalis would be used in auricular fibrillation or flutter; for the rest, it was important to avoid hypoxia, fall in blood pressure and excessive infusions. Finally there was the danger of uraemia, especially from overlooked prostatic enlargement. Analgesics should be sparing.

Professor H. Debrunner (Zurich) recalled that the power of regeneration diminishes from childhood to senility. It had been estimated that in 1980 almost 20 per cent of Europeans would be over sixty years old, and older people would have to work longer. What paediatrics had done for the children, geriatrics might perhaps do for the elderly, but the child was father of the man, and the health of the elderly was the culmination of his previous way of life, illnesses and accidents. Senile osteoporosis, a response to diminished function, was a normal end-state, but osteoarthritis was not, and often it had its roots in youth. For instance an osteoarthritic hip often followed a slipped epiphysis and emphasised the need for early diagnosis. In one Swiss valley there were many congenitally dysplastic and dislocated hips, and many osteoarthritic hips. Senile osteoarthritis should be fought in childhood.

The physiological background of maximal performance in sport—*Mr E. Hohwü Christensen* (Stockholm) said that sport represented the extreme of physical work, in which oxygen intake might increase twenty times or more, with a corresponding increase in respiratory volume, circulation rate and heat elimination. He would consider these factors to the exclusion of such things as body build, power and co-ordination. In brief events and the early stages of longer ones, the processes were largely anaerobic, but later in the longer events heart and lung might dominate the picture. Maximal oxygen intake, lung ventilation, vital capacity and tidal air increased with age and weight, and were greater in men than in women. The total haemoglobin and the blood volume were about equal in boys and girls, but greater in men than in women.

Professor Alexander von Muralt (Berne) spoke of muscular activity and maximal performance. Contraction and relaxation were caused by changes in the molecular configuration of actomyosin, and maximal performance depended on the speed at which this could be brought about by a chain of chemical reactions.

Dr E. Grandjean (Zurich) spoke of muscle training (in which adaptation came from nerve training for muscle command), morphological adaptation, and chemical and functional adaptation

of the muscles. Training increased the number of capillaries, the glycogen, the phosphocreatine and the haemoglobin in the muscles. Static (isometric) exercises particularly increased endurance for anaerobic work (posture, etc.), whereas quick dynamic (isotonic) exercises developed muscle power which manifested itself in speed.

Physiopathology of fractures—*Dr René Patry and Dr Angelo Canossa* (Geneva) contended that, because capillary circulation plays a leading part in repair of a fracture, and because haemorrhage and oedema tend to raise the pressure within the envelope of deep fascia, it is necessary to allow a little shortening, say 2 centimetres, in treating fractures in order to maintain capillary permeability and promote healing. The point was illustrated with an ingenious model.

Osteoarthritis of the hip—histology of the pressure-bearing and non-pressure-bearing areas. Vascularisation, in the femoral head of the aged—*Dr E. Rutishauser and Dr Ed. Grasset* (Geneva) had studied advanced cases of osteoarthritis of the hip. In the parts taking pressure there was vascular hyperplasia, with stasis and fibrosis which could pass on into eburnation. The non-weight-bearing part presented a normal circulation except where there was proliferation of cartilage, morphologically resembling, but distinct from, osteophytes. The changes were distinct from those of senility.

Indications for osteotomies and arthroplasties in osteoarthritis of the hip—*Dr Adolphe Perrot* (Geneva) disapproved the misuse of internal prostheses in the treatment of osteoarthritis of the hip, and the neglect of less spectacular operations such as the osteotomies of Pauwels and McMurray which, in some well-defined cases, could give better results than the best arthroplasty. Arthrodesis was an excellent operation in young people, and arthroplasty should usually be reserved for the elderly.

Muscular degeneration and its treatment—*Dr A. Fleisch* (Lausanne) reviewed the phenomenon of muscle degeneration after denervation. Massage and passive movements did no good in experimental animals, but electrical stimulation diminished weight loss, atrophy and fibrosis. With suitable speed of ascent and frequency, the threshold of excitability of the degenerated muscle was much less than that of normal muscle, making possible a selective excitation of the degenerated elements.

Osteoarticular tuberculosis—*Dr Etienne Sorrel* (Paris) said that the antibiotics had been used in the treatment of tuberculous joints for long enough to assess what might be expected of them, namely to improve the patients generally, to hasten quiescence, drying of abscesses and closing of sinuses. They could not be expected to cure without climatic, orthopaedic and surgical treatments. The return of tuberculous patients to work was helped by giving them work in sanatoria to counter the detrimental effect of prolonged inactivity. To retrain those who could not return to their previous occupations benefited not only them but society.

Antibiotics in osteoarticular tuberculosis—*Dr Pierre Gerard-Marchant* (Paris) said that streptomycin and, as an accessory, isoniazid had changed the prognosis of bone and joint tuberculosis by limiting anatomical destruction though having no action on repair. They would not strikingly accelerate recovery but would improve its quality. They did not dispense with general, mechanical and surgical treatment.

Return to work of patients with bone and joint tuberculosis—*Dr Michel Wasserfallen* (Leysin) stressed the importance that patients should have work and not merely occupation during prolonged treatment like that for tuberculosis. The work should be organised in true industrial fashion and not depend upon charitable outlets. At Leysin a manufacture had been organised on industrial lines, the convalescent patients were usefully employed, and they were paid regularly in proportion to the amount and standard of their work.

The legal bases of accident medicine in Switzerland—*Dr Fritz Lang* (Lucerne), Chief Medical Officer of the Swiss National Accident Insurance Fund, described it as a statutory body entrusted with compulsory accident insurance, covering occupational and non-occupational accidents and occupational diseases in most industrial workers. These numbered about one million in 60,000 undertakings. Hospital, hotel, restaurant and domestic staff were excluded. There were about 300,000 accidents a year. Medical care, sick allowance and disability and survivors' pensions were provided. A spa and a rehabilitation centre for those suffering amputations were provided, and also small hospitals to serve electricity stations under construction high in the mountains. Medical students received instruction and had to pass an examination in accident medicine.

Exhibition

The scientific exhibits were surprisingly few—in fact only three collections—but remarkable both for their substance and display.

Our hosts displayed a superb collection of early books connected with orthopaedics, and some most interesting ancient appliances and instruments.

Mr John Charnley (Manchester) showed preparations and most ingenious models designed to establish experimentally that high pressure between fresh bone surfaces promoted callus formation —not absorption—and " first intention " osseous union within four weeks. He showed too that this happy result was the consequence of pressure and not just immobilisation.

Dr J. T. Scales (Stanmore) illustrated, with exceptionally good photographs and diagrams, the problems of replacement of bones and joints by internal prostheses, and clinical cases of their use at the Royal National Orthopaedic Hospital, with a continuous moving picture of the functional results in patients after a lapse of years. From the Institute of Orthopaedics, he demonstrated also his experimental work in goats; a large part of the femur had been replaced by a prosthesis, round which he had induced the growth of a sheath of bone intended to supplement its potentially weak anchorage to the rest of the shaft.

Badge of office of President of the Congress, presented to SICOT by the British Members. Based on the seal of the Society, devised by Henry Meyerding in 1947, the badge was designed by Miss E. M. Scott of Liverpool and made by Messrs R. C. Shackman and Sons of Golden Square, London.

Business Meeting

At the General Assembly, Professor Bryan McFarland, British delegate, asked Sir Harry Platt to accept on behalf of the Society a Badge of Office given by the British members as a mark of their interest in the Society and their faith in its future. Sir Harry Platt formally acknowledged the Badge, and, after wearing it a few minutes, he placed it with a graceful acknowledgment round the neck of the President of the Congress, Dr Etienne Sorrel.

Dr J. Delchef (Brussels), Secretary General, reported the loss by death of Jean Massa and Clément Van de Voorde (Belgium), Nicolas Nedkow (Bulgaria), Antoine Pouillot (Canada), Aage Berntsen (Denmark), Jacques Calvé and Etienne Loubat (France), H. A. Brittain and V. H. Ellis (Great Britain), Athanase Contargyris (Greece), Silvio Grainz (Italy), Joseph Komza (Poland), Riba de Sanz (Spain), Placide Nicod (Switzerland), and Myron Henry, A. Jostes, H. Macey, D. B. Phemister, W. Plummer and M. N. Smith-Petersen (United States of America). Dr Delchef recalled that, in twenty-five years, membership of the Society had grown from ninety-two members,

representing eighteen countries, to one of 528 members from forty-three countries. He paid a graceful tribute to Sir Harry Platt, retiring after six years' tenure of the office of President of the Society, to Professor M. Dubois for his able organisation of the meeting and to Professor R. Scherb, who was too ill to attend.

Two new national committees were enrolled, representing: Ceylon (provisional national delegate, Mr J. F. Silva) and the Philippines (national delegate, Dr Augusto S. Besa). One hundred and fifty-three new members were elected.

Sir Harry Platt announced that he would be succeeded, as President of the Society, by Dr J. Delchef, rightly saying that Dr Delchef had saved the Society after the war, and, as its secretary ever since, had served it with the greatest distinction. This election was received with particular pleasure. Professor J. Trueta (Oxford) joined Professor J. Valls (Buenos Aires) as Vice-President.

The Treasurer's report revealed a healthy financial position, and it was agreed that the present subscription need not be increased.

Plans for the Congress in 1957—It was agreed that the next meeting, in 1957, should be held in Barcelona, the principal subjects to be: 1) The Influence of Growth on the Sequelae of Bone and Joint Injuries (Rapporteur, Dr P. L. Chigot of Paris), and 2) Flail Joints (Rapporteur, Professor G. Hohmann of Munich).

Entertainment

The Swiss were the charming and accomplished hosts that we have always known them to be, and they added generous entertainment to the delights of their country. Those attending the congress, and especially the ladies, saw much of the Swiss countryside, mountains, history, culture and industry. Events and scenes that stand out are dinner by invitation of the congress organisers at a Bernese country inn, with rural entertainments, a concert in the Cathedral, the trips to Swiss medical centres and the hospitality there, the view of the distant Alps from the terrace of the Kursaal where the meeting was held, and the visits to these very mountains after the congress. The Swiss and their country always seem too good to be real.

THIRD EUROPEAN RHEUMATOLOGY CONGRESS

The third European Rheumatology Congress will be held at Scheveningen, The Hague, Netherlands, under the auspices of the Ligue Européene contre le Rhumatisme from June 13–17, 1955. The honorary president of the congress will be Dr J. van Breemen, the chairman Mr E. M. Bingen, and the secretary Dr J. J. de Blécourt.

The scientific programme will include four sections: 1) rheumatic fever; 2) connective tissue; 3) osteoarthritis of the spine and disc degeneration; and 4) rheumatism and social medicine. Further details may be obtained from the Secretary, Third European Rheumatology Congress, Pieter Bothstraat 12, The Hague, Netherlands.

Book Reviews

DISEASES OF THE KNEE. By Anthony F. DePalma, M.D., James Edward Professor of Orthopaedic Surgery, Jefferson Medical College, Philadelphia. $10\frac{1}{4} \times 7\frac{1}{2}$ in. Pp. xxi+840, with 455 figures. Index. 1954. Philadelphia, London, Montreal: J. B. Lippincott Company. Price £8.

This work possesses in full measure the virtues of American books on orthopaedic subjects. Not only is it beautifully produced, well illustrated and fully documented, but the writing reflects wide clinical experience. The author has already written a similar source-book of information on surgical conditions of the shoulder. Again he has discussed many valuable procedures, a fairly typical one being Thompson's technique of isolation of the rectus femoris muscle in the treatment of severe stiffness of the knee joint. The author has found it much more satisfactory than the Bennett procedure of lengthening the quadriceps tendon. In the technique advocated for arthrodesis of the knee, a modification of the Key-Charnley method, rubber bands are used for compression and the author can claim a consecutive series of no less than eight successful fusions of Charcot joints. For sound reasons such as these the symposium is bound to have good reviews; so any minor criticisms made here cannot dull its lustre.

Fig. 221 (F)
One of the drawings illustrating Thompson's technique of lengthening the quadriceps apparatus.

Take for a start the size of the book. Because it runs to eight hundred pages and weighs five pounds it is very much a library volume. In fact, the catalogue card number of the Library of Congress is already there on the title page. This disconcerting weight of paper is a matter which any author should consider if he wants his book to have an everyday circulation and use, at least on this side of the Atlantic. Condensation down to half would improve the book enormously and could be done at a trifling expense of ideas or information. For example, the chapters on evolution and on comparative anatomy are so learned, and the one on normal anatomy so elementary, that the greater part of them could be jettisoned without loss. The order of the chapters has produced much repetition. For example, surgical approaches and procedures are found in the eighty pages of chapter 13, by which time most of them have already been described two or three times over. Then again, various subjects such as rheumatoid arthritis, spastic paralysis and bone neoplasms are introduced by general essays which take nothing for granted about the medical education of the reader. Many of the otherwise excellent illustrations by Carl Brill are quite unnecessarily large; three nearly full-size plates, for example, are devoted to simple techniques of reattachment of the anterior cruciate ligament, whilst another large illustration is not referred to anywhere in the text.

Quite a number of the subjects discussed are of course controversial. For example, the author considers that the patella plays a very important function in enhancing the power of the quadriceps apparatus and deplores the frequency with which it is excised. This leads him to disregard the constancy of lesions of cartilage found in recurrent dislocation of the patella, so that he allows patellectomy no place in its treatment. For chondromalacia patellae the author advocates a vitallium prosthesis of the type designed by Duncan McKeever of Texas for replacement of the damaged articular surface. It will be interesting to see whether this enthusiasm is maintained.

A few omissions might be remarked upon. For example, Lambrinudi's paper on double lesions of the menisci has escaped notice and also the virtues of reed osteotomy for the correction of rotation deformity of the tibia. In the technique of excision of the meniscus the

use of thin tenotomy knives is noted but no warning is sounded about the risk of breakage of a blade inside the joint. The omission of two important accents in the spelling of Calvé and Fouché is worthy of comment.

Many readers will be grateful for the wealth of information collected in this volume, which bids fair to become a standard work of reference.—K. I. NISSEN.

MULTIPLE MYELOMA. By I. SNAPPER, M.D., Director of Medical Education, Cook County Hospital, Chicago, Illinois; Louis B. TURNER, M.D., Research Assistant in Medicine, Mount Sinai Hospital, New York; and Howard L. MOSCOVITZ, M.D., Resident, Second Medical Service, Mount Sinai Hospital, New York. $9\frac{1}{2} \times 6\frac{1}{2}$ in. Pp. vii + 168, with 43 figures, colour frontispiece and 15 tables. Index. 1953. New York: Grune and Stratton. Price $6.50.

It is now over a hundred years since MacIntyre gave the first description of myelomatosis under the term "Mollities et Fragilitas Ossium." The patient, a grocer aged forty-seven years, had sustained multiple pathological fractures, and Bence Jones found a peculiar protein in the urine which has since been the subject of much speculation and research. Until recently myelomatosis was thought to be one of the rarer bone tumours; but improved diagnostic techniques have shown that, with the exception of metastatic carcinoma, it is probably the commonest

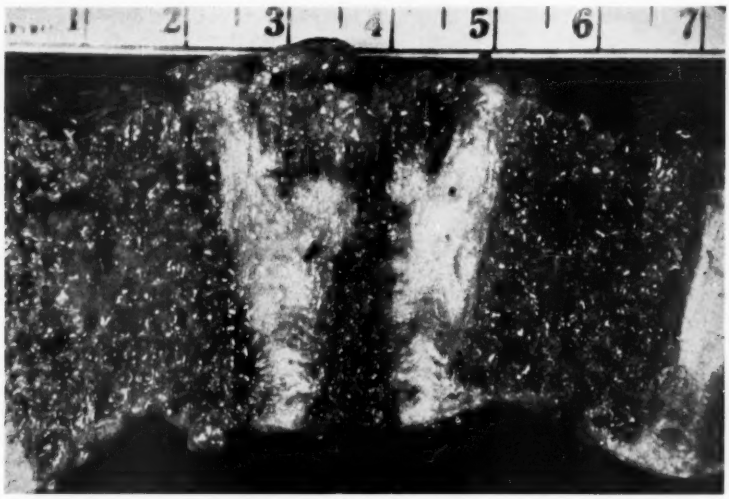


FIG. 38

Pathologic specimen demonstrating collapse of vertebral body infiltrated by multiple myeloma. Note the gelatinous appearance of the marrow.

malignant tumour of bone. Although pathological fractures are common many of those afflicted seek treatment for one of the complications of the disease such as uraemia, bronchopneumonia, cachexia, or neurological symptoms.

The appearance of this splendid monograph by Snapper, Turner and Moscovitz is opportune, for it presents clearly and succinctly with a wealth of illustration the protean manifestations of this remarkable disease. The authors incline to the view that myelomatosis is not a true tumour but a proliferative disorder of the reticulo-endothelial system. Although the areas of bone destruction appear to be discrete there is usually generalised involvement of the bone marrow, and the diagnosis can best be made by examination of a smear of marrow obtained from the sternum or iliac crest.

The renal complications of myelomatosis are interesting and important. Bence Jones protein is precipitated in the renal tubules and may cause a non-hypertensive type of uraemia. The complication occurs only in the 55 per cent of patients who have Bence Jones proteinuria, and these patients usually have a comparatively low serum globulin, for there appears to be an inverse relationship between Bence Jones proteinuria and hyperglobulinaemia. The authors discuss at length the abnormal serum proteins that are found in myelomatosis and the place of electrophoresis

and ultra-centrifugation in the separation of the globulin fractions. The calcium content of the serum is often increased; a high value indicates rapid demineralisation of the skeleton and a poor prognosis.

Bone pain is the commonest symptom of the disease, and 40 per cent of patients have pathological fractures of the spine (Fig. 38); about a quarter of the patients have palpable tumours. Treatment is unsatisfactory; most patients die within two years of the first symptoms with or without treatment. Radiotherapy often relieves bone pain but the effect is temporary and a second course of treatment may be without effect. Stilbamidine, urethane, cortisone and A.C.T.H. all produced a remission of the disease in a few patients, but all of these drugs were liable to cause unpleasant side effects.

This book is a pleasure to read. It is short, well produced, contains a great deal of information most palatably presented, and has a comprehensive bibliography.—Roland BARNES.

LESIONS OF THE LUMBAR INTERVERTEBRAL DISC. By R. Glen SPURLING, M.D., Clinical Professor of Surgery (Neurosurgery), University of Louisville School of Medicine, Louisville, Kentucky. $9\frac{1}{2} \times 6\frac{1}{2}$ in. Pp. xi+148, with 45 figures. Index. 1953. Springfield, Illinois: Charles C. Thomas, Publisher. Oxford: Blackwell Scientific Publications. Price 34s.

This short monograph affords an opportunity to compare the neurological and orthopaedic approaches to a common problem. Containing six chapters and touching on every aspect of lumbar disc lesions, the book is curiously patchy, some sections being complete and detailed while others are vague and much over-simplified.

The historical chapter is adequate, if brief. While sharing the author's view, however, that much misunderstanding stems from confused nomenclature, one cannot agree that "rupture of the intervertebral disc with herniation of the nucleus pulposus" is either an accurate or logical description of a lesion which passes through three stages. The anatomical and functional chapter is also adequate although the physiology, and in particular the fluid exchange, is over-simplified.

The chapter on pathology is disappointing. The author's attention appears focused on annular rupture and nuclear extrusion, and the very important changes that precede and follow at this stage are ignored. Extensive reference to disorders of the cartilaginous end-plates which take place in the thoracic [dorsal] region is irrelevant and confusing. No real suggestions are made about etiology; it is not even made clear that the basic cause of disc lesions is unknown. It is, however, refreshing to find a clear statement that once rupture of the annulus has occurred the disc can never be restored to normal, a fact widely unappreciated.

The clinical chapter is by far the best in the book. The section on differential diagnosis is sketchy, but on the other hand the sections on neurological findings and, particularly, on myelography are exemplary. Because of views recently expressed in this country, it is interesting to note that myelography is reserved for selected cases.

The chapter on therapy is mainly concerned with operation. Conservative treatment is dismissed in two pages, and, although one gathers that the author believes in rest and immobilisation and condemns the many useless measures so often employed, there is little to guide those who have to deal with the 90 per cent or so of patients who do not require surgery. The indications for operation are fully discussed and the author's technique is described. He employs an interlaminar approach, and if a lesion is found at the expected level does not explore the second of the two lower discs. Few surgeons in this country would share the choice of anaesthesia or of the prone position, and no orthopaedic surgeon with a proper respect for the posterior articulations should remain unmoved by the advice that, after a negative exploration, "the suspected nerve root (roots) should be well decompressed by removing the posterior rim of bone and the ligamentum flavum of the intervertebral foramen." The section on post-operative management is strangely indecisive: the author's obvious knowledge of the best conditions for healing of the damaged intervertebral joint seems to be in conflict with his familiarity with the post-operative regime practised by other neurosurgeons. In the final chapter the results of treatment of various sorts of patient are analysed, and two main conclusions appear to emerge. Few would quarrel with the view that, whatever the shortcomings of operation may be, the prospects of a patient who has failed to respond to conservative treatment would be far more dismal without surgery or that a surgeon's operative results improve as his personal experience of this particular problem increases.

Because of its primary concern with the neurological aspect and operative treatment, this monograph cannot be regarded as a comprehensive guide to the disc lesion. Nevertheless it can be read with pleasure and profit by all those already experienced in this field of surgery.—J. R. ARMSTRONG.

THE FOUNDATIONS OF SURGERY. By George PERKINS, *M.C.*, M.Ch., F.R.C.S., Professor of Surgery, London University; Orthopaedic Surgeon, St Thomas's Hospital. $7\frac{1}{4} \times 4\frac{3}{4}$. Pp. viii + 236. Index. 1954. Edinburgh and London: E. & S. Livingstone Ltd. Price 10s.

" Surgery for Toddlers," as its author calls it, is the child of an orthopaedic surgeon become professor of surgery; here are his thoughts on impetigo and the icteric index almost side-by-side with the distinction between dislocation and subluxation. This pithy, epigrammatic work deals with two things: first, the group of subjects that so ponderously introduce every surgical text-book—healing, inflammation, infection, gangrene and so forth; and secondly clinical examination of the patient. In this the student is encouraged to develop his own methods at the bedside, as he must, but the necessary introduction is well set out. The author's brevity, lucidity and logic are the symbols of clear thought and of the successful teacher of undergraduates, who must needs forget that frail, feminine Nature is not always to be wooed by logic. We only wish that the student could be introduced to every subject—anatomy, physiology, physic and so on—by such a book and such a teacher. One criticism we have. Professor Perkins learnt his anatomy when the books used one terminology (B.N.A.) and many teachers another (the " old "). Now all British anatomists teach in a third nomenclature (Birmingham revised—much the best of the bunch), and are threatening a fourth. This isn't Professor Perkins's fault, but he ought to write the language that his readers know; brackets are the place for the old (os calcis, etc.) or the nondescript (" subtaloid "). The book reflects the sparkle of its author.—H. Jackson BURROWS.

STUDIES ON HIBBS' SPINE FUSION IN THE TREATMENT OF SCOLIOSIS. By Bjarni JONSSON. $9 \times 6\frac{1}{4}$ in. Pp. 139, with 46 figures, 9 tables, and case histories with many figures. 1953. Acta Orthopaedica Scandinavica, Supplement 14. Copenhagen: Ejnar Munksgaard. Price D. kr. 30.

This monographic supplement is of interest to all who are studying this difficult subject. There are several reasons why they should find it so. One of these is that there is a very large bibliography of the suggested causes and treatment of the deformity; there are some 184 references. Another is that the material on which the paper is based is a careful analysis of 208 patients with scoliosis operated on at the New York Orthopaedic Hospital. Certain indications for operation are discussed, and the results of spinal fusion analysed from all possible angles. The average maintained correction in 138 cases followed for five or more years was 18 degrees. The final forty-two pages consist entirely of case reports, with clinical photographs and radiographs. There are many things that every student of the subject will disagree with. This is true of any extensive writing on this subject.—J. C. SCOTT.

THE MUNKSFORS INVESTIGATION. A study of the Frequency and Causes of the Stiff Neck-Brachialgia and Lumbago-Sciatica Syndromes, as well as observations on certain Signs and Symptoms from the Dorsal Spine and the Joints of the Extremities in Industrial and Forest Workers. By Lennart HULT, from the Orthopaedic Clinic of Karolinska Institutet, Stockholm. 9×6 in. Pp. 76, with 54 tables. 1954. Acta Orthopaedica Scandinavica, Supplement 16. Copenhagen: Ejnar Munksgaard. Price D. kr. 12.

Essentially this is a statistical study of the etiology and frequency of cervical and lumbar pain syndromes, and their association with radiological degenerative changes, in some five hundred persons chosen from three different types of worker. Boys and youths of miscellaneous occupations form the first group, sheet-iron workers the second, and foresters employed in heavy work under difficult climatic conditions the third. The investigation also embodies similar observations on disabilities of the limbs and peripheral joints. So comprehensive a clinical adventure of this sort, into the tangled jungle of skeletal pain, is liable to become lost in detail and produce a host of facts of doubtful value. In this study the field of investigation has been well disciplined, permitting simple conclusions which are significant but not startlingly novel or contrary to general belief.

It is interesting that 80 per cent of adult heavy workers under fifty have suffered from cervical pain and a similar percentage from lumbar pain, but that only 15 per cent of those with cervical pain, in contrast to 55 per cent of those with lumbar pain, have found the symptoms serious enough to prevent work. Like many others, Hult attaches no etiological significance to the various congenital anomalies of the lower lumbar spine and sacrum. In the thoracic spine, pain syndromes with radiological degenerative changes are much fewer than elsewhere.

This is a valuable work of reference for all investigating this subject and a guide to those particularly interested in the problems of labour and invalidism.—Philip NEWMAN.

NATURE AND STRUCTURE OF COLLAGEN. Papers presented for a discussion convened by the Colloid and Biophysics Committee of the Faraday Society at King's College, London, on March 26 and 27, 1953. Edited by J. T. RANDALL, F.R.S., Honorary Director, Medical Research Council Biophysics Research Unit, and Wheatstone Professor of Physics, University of London. Assisted by Sylvia Fitton JACKSON, Medical Research Council Biophysics Research Unit, and Strangeways Research Laboratory, Cambridge. 9×6 in. Pp. ix+269, with numerous figures. Index. 1953. New York: Academic Press Inc. London: Butterworth's Scientific Publications. Price 42s.

Collagen is the main organic constituent of all the supporting tissues such as bone, tendon, ligament, cartilage, and the other connective tissues. Indeed the cross-banded collagen fibrils as defined by the electron microscope can be regarded as the essential building bricks of the whole fibrous structure of the supporting system. Collagen is thus the main raw material that the orthopaedic surgeon has to mould and modify in his daily work, and any precise information about it would clearly be of great value.

Recent developments in biophysics and biochemistry have provided much new information about the fine structure of the collagen fibril, the chemical constitution of collagen and the relation between collagen and other connective tissue constituents. The introduction of isotope-labelled amino-acids has also opened up the hitherto unexplored problems of connective tissue metabolism. Workers in these various fields were invited to contribute to a Symposium on the Nature and Structure of Collagen which was held at King's College, London, in March 1953 under the auspices of the Faraday Society; this volume is a record of that meeting and contains both the original contributions and the ensuing discussion.

As might be expected Professor Randall's own department is responsible for many of the contributions. These include electron microscope studies of the fine structure of cartilage, and of fibrogenesis in vivo and in vitro. His department is also responsible for contributions on the physical properties of collagen extracts, and a study of the fascinating long spacing and other variants of the collagen fibril that can be reconstituted from solutions of collagen. Dr Happey reports some interesting x-ray crystallographic studies of the human intervertebral disc, and there is an excellent paper by Drs Kramer and Little on the nature of reticulin and its relation to collagen which does much to clarify this controversial question.

The studies of collagen metabolism reported by Dr Slack and Dr Neuberger and his associates reveal that the main mass of fibrous collagen is metabolically very inactive and that when laid down it remains outside the metabolic pool for long periods. In growing tissue however there is a more soluble collagen precursor that has a rapid metabolic turnover. Reports by other workers show that the more soluble collagen precursor has also a different chemical constitution, and the picture that emerges is that the very stable metabolically inactive collagen fibre of adult tissues may result from the "fixing" of the collagen precursor by the addition of a tyrosine-containing protein or polypeptide and polysaccharide such as chondroitin sulphate. The orthopaedic implications of these findings have yet to be worked out but it is clear that fundamental observations of the type reported in this Symposium cannot fail to influence the thought and practice of those of us who are handling connective tissues in patients.

There are many other interesting contributions dealing with such diverse subjects as the histochemical identification of connective tissue antigen, the hot and cold forms of gelatin and the molecular structure of collagen. The volume is profusely illustrated by 103 photographs, thirty-six diagrams and twenty-eight tables and can be recommended as a source of up-to-date information about a rapidly developing subject.—J. H. KELLGREN.

PRESERVATION AND TRANSPLANTATION OF NORMAL TISSUES. A CIBA FOUNDATION SYMPOSIUM. Editors for the Ciba Foundation, G. E. W. WOLSTENHOLME, O.B.E., M.A., M.B., B.Ch.; and Margaret P. CAMERON, M.A., A.B.L.S., assisted by Joan Etherington. 8½×6 in. Pp. xii+236, with 55 figures. Index. 1954. London: J. & A. Churchill Ltd. 25s.

In these days when dead or missing human tissues are to an ever increasing extent being surgically replaced by equivalent material imported directly or through the medium of a " bank " from a human donor, an exposition of the underlying biophysical principles is most opportune. Consequently the present symposium is likely to be as essentially useful as it is welcome. It deals extensively with the culture of tissues in general and the preservation and transplantation of special tissues in particular. The presentation is clear and interesting, and the discussions are comprehensive and illuminating. Of particular interest to orthopaedic surgeons is the classification of homografts into two large categories depending upon their functional requirements, under the names (after Longmire) homostatic and homovital. The titles are fully explained with appropriate examples. Similarly the analysis of thermal stress on tissues that are being stored by freezing deserves special attention. Altogether it is an attractive and helpful book.—Bryan MCFARLAND.

PERIPHERAL CIRCULATION IN MAN. A CIBA FOUNDATION SYMPOSIUM. Editors, for the Ciba Foundation, G. E. W. WOLSTENHOLME, O.B.E., M.A., M.B., B.Ch.; and Jessie S. FREEMAN, M.B.; D.P.H.; assisted by Joan Etherington. 8½×6 in. Pp. xi+219, with 72 figures. Index. 1954. London: J. & A. Churchill Ltd. Price 25s.

This fascinating little book records the papers and subsequent discussions at a symposium held under the auspices of the Ciba Foundation on the subject of peripheral circulation in man. The participants, several from abroad, and all interested in various research aspects of peripheral circulation, consisted of physiologists, experimental pathologists, physicians and surgeons, the latter perhaps having most practical interest and experience in the subject. The Chairman, Professor Edholm of the M.R.C. Laboratories, Hampstead, opened the proceedings by saying that human physiology was still regarded with suspicion by a number of physiologists because of its own special difficulties as a consequence of which " the results of research on humans are not always as clear-cut as in animal experiments." He also stressed that " it is not always possible to apply the findings of animal experiments to man," a fact that surgeons, at any rate, have known for many years. It would not be useful to quote extensively from this book—it must be studied by anyone interested; and there he will find the high standards and severe discipline demanded by research workers, and will, we suggest, capture some of the thrill of seeking after truth.

Dr Alan C. Burton from Toronto discussed eight different ways of measuring blood-flow, namely, by direct observation on vessels, by skin colour, by skin temperature, by colormetric and plethysmographic methods—all of which have been used in clinical circles for thirty years—and then, by circulation time, by employment of dyes on the Fick principle, and by clearance methods with radio-active salts, and these, of course, are more recent and require special equipment. Dr G. E. Burch from Louisiana, gave a detailed description of " a method for measurement of the time course of the rate of blood flow into and out of the finger tip of man during a single pulse cycle," and this was followed by a description of other techniques for the measurement of blood flow in the digits.

Two very interesting papers by Dr U. S. von Euler from Stockholm and Dr R. F. Whelan from Belfast, dealt respectively with the differential secretion of adrenalin and noradrenalin by the suprarenal gland, and the effect of these two hormones on blood flow through human skeletal muscle. Dr von Euler makes the interesting suggestion that there may be either two different types of cell in the suprarenal medulla, or else two types of nerve fibre controlling the same cells.

Then follow two papers on circulatory response to cold, the first by Dr Loren D. Carlson from Seattle, in which he shows that cold-adapted persons tend to keep warmer extremities than does the individual freshly exposed. The second paper, by Dr A. D. M. Greenfield of Belfast, seeks to find the chemical factor involved in response to cold.

Professor H. Barcroft and Dr A. C. Dornhorst's paper from St Thomas's Hospital, showing that on occasions there is vaso-dilatation in the hand whilst the foot is immersed in cool water, and vaso-constriction when in warm water, struck consternation even amongst this group of research workers, and stimulated almost the longest and most lively discussion of any.

A new technique for studying the neuro-histology of cutaneous blood vessels is described by Dr G. Weddell of Oxford, and its use should lead to more detailed knowledge of the innervation of capillaries and arterioles.

A most interesting suggestion emerges from the contribution of Dr K. E. Cooper of the M.R.C. Laboratories and Dr D. McK. Kerslake of the R.A.F. Institute of Aviation, namely, that two possible factors are responsible for the reflex heating that follows the several tests in common clinical use. Reflex dilatation of hand vessels after heating of the trunk by electric cradle occurs too quickly to be caused by hot blood reaching the upper limb; it is almost certainly due to stimulation of nerve endings in the heated area. If heat is applied to the legs with a warm bath, the reflex dilatation by hands is much slower, and is then probably due to " hot blood."

A study by a team of workers from St Louis University confirms the extremely variable and unpredictable patterns of sympathetic innervation to the vascular tree of the limbs, and so offers no help to the surgeon, who has been for years only too aware of the problem.

In the discussion following Dr R. F. Grant's (Guy's Hospital) paper the observation was recounted by Mr Martin, of the Postgraduate School, that occasionally a successfully sympathectamised hand may sweat on about the second post-operative day and then never again. Your reviewer, who, incidentally, performed some of the first dozen cases of sympathectomy in this country and, therefore, has a few cases for follow-up of twenty-five years standing, has witnessed this on several occasions. Sometimes it is just a matter of transudation occurring in hands held in contact one with the other, but sometimes it is an active secretion of unknown mechanism.

Professor J. H. Dible of London described his experiments with arteriograms in amputated limbs (the medium being injected under high pressure), and stressed the extraordinary distortion of the normal pattern that can occur in arterio-sclerosis. These studies reveal the smaller collaterals in much greater detail than do arteriograms in the living. They also confirm that athero-sclerosis affects the larger vessels whereas it is the smaller ones, such as the digitals, which bear the brunt in thrombo-anginitis obliterans.

Finally, there is a most fascinating account by Dr L. Guttmann, of the Spinal Injuries Centre at Aylesbury, of his observations on the vaso-motor reflex responses to distension of the bladder in patients suffering from paraplegia at different levels. He summarises by saying that " from a clinical point of view, knowledge of these responses by autonomic mechanisms in paraplegic patients is important—since they may be the only indicator of impending abdominal catastrophe."
—F. A. R. STAMMERS.

DIGITAL PLETHYSMOGRAPHY. By George E. BURCH, M.D., F.A.C.P., Henderson Professor of Medicine, Tulane University School of Medicine. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. viii + 134, with 83 figures. Index. 1954. New York: Grune & Stratton. Price $5.00.

The present reviewer has reported above the verbatim account of the symposium organised by the Ciba Foundation on the subject of peripheral circulation in man. That account gave a bird's eye view of the research that is going on in Great Britain and the United States concerning the many problems of peripheral circulation, together with the discussions that followed the different papers. Amongst these was one by Dr George E. Burch, Professor of Medicine in Tulane University, giving a brief description of his work on digital plethysmography. The monograph now under consideration is Dr Burch's full account of his " method for recording simultaneously the time course of the rate of blood-flow into and out of the finger tip."

For these studies Dr Burch encloses the finger tip in a plethysmographic cup immediately against which is a pneumatic cuff by which venous return can be occluded at will. The cup is connected to a suitable volume recorder which traces on photographic paper the variations in volume of the isolated finger-tip with time at 0·4 second intervals. By correlation of these, the " time-course " of rate of blood flow per 5 cubic centimetres of tissue is calculated.

The apparatus is described in detail, and possible sources of error, including that produced by the juxtaposition of the occluding cuff with the plethysmograph cup, are fully discussed. Indeed, a special section is devoted to this, since many other workers have deliberately avoided placing the occluding cuff against the cup because of this artifact: instead they put it more proximally, at the base of the finger concerned. Since the artifact can be measured and correction made, Dr Burch prefers the distal position, maintaining that more accurate observations are possible.

All observations are made under standard conditions, the patient being recumbent in bed with the arm on a special rest so that it is comfortable and the finger being tested is at heart level: and the experiments are carried out in a special automatically and continuously controlled air-conditioned room.

The author then describes what he terms " orienting reflexes," resulting from such factors as the tactile stimulus of the inflated cuff; the phase of the pulse wave; a sudden noise; a flash of light; a deep inspiration; whether the observed finger is above or below heart level; variations in environmental temperature and humidity; all of which may through the medium of vaso-constriction or vaso-dilatation change the pattern of the plethysmogram.

All these features go to show how difficult it is to discover even the simplest facts about normal peripheral circulation, at the same time stressing what a living thing the vascular tree of a limb really is, constantly changing in tone as psychogenic, neurogenic, chemical and physical influences play upon it.

Dr Burch is a physician and is obviously working up to investigations on cases of peripheral arterial disease: only a few experiments in victims of Raynaud's disease are mentioned in the monograph. From the surgeon's point of view, similar observations on the toes of normal individuals, not only in recumbency but also in their more usual position, namely dependent, as also under the influence of exercise, would be of the greatest interest: and, of course, further observations in diseased states might reveal something that could be used as a test which would serve as a pointer to the form of treatment most likely to help in a particular case, at the same time being a means of measuring progress. So far we have to depend almost entirely on clinical signs and a few rough tests.

Anyone wishing to enter into this difficult though important field of work will learn much from this short book.—F. A. R. STAMMERS.

LIVING WITH A DISABILITY. Edited by Howard A. RUSK, M.D., Director, Institute of Physical Medicine and Rehabilitation, New York University; and Eugene J. TAYLOR in collaboration with Muriel ZIMMERMAN, O.T.R., and Julia JUDSON, M.S. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 207, with 275 figures. Index. 1953. New York: The Blakiston Company Inc. Price $3.50.

Rusk and Taylor of New York have collected together in this small book a great deal of information to help the physically handicapped live more normal lives. They completely cover the present American range of gadgets designed to help in eating, drinking, dressing and cooking; in fact, most aspects of living. The illustrations are good and fit into the descriptions of each gadget to make understanding easy. No medical terms are used, and the book is full of good sense and general advice to the disabled. It should be a part of the library of every rehabilitation centre, and will be a source of inspiration both to disabled people and to those looking after them.—L. W. PLEWES.

GADGETS. Produced by the National Association for the Paralysed, Tavistock House (South), Tavistock Square, London, W.C. 1. $8\frac{1}{4} \times 6\frac{3}{4}$ in. Pp. vii+32, with 9 figures. 1953. Southwick, Sussex: The Grange Press. Price 2s. 6d.

The National Association for the Paralysed have produced a loose-leaf booklet which lists and describes gadgets and appliances manufactured in Great Britain to help disabled people overcome their handicaps. Information about where the articles may be obtained and the cost are included, and there are a few diagrams. This booklet should be on the desk of every almoner attached to an orthopaedic or accident service, and would be found useful as a reference book by orthopaedic surgeons and consultants in physical medicine.—L. W. PLEWES.

BOOKS RECEIVED

These books are acknowledged with grateful thanks. Selections will be made for review as space permits and in accordance with their interest for our readers.

RECURRENT DISLOCATION OF THE SHOULDER. By James A. Dickson, M.D., Alfred W. Humphries, M.D., and Harry W. O'Dell, M.D. 1953. London: Baillière, Tindall and Cox.

THE EFFECT OF CORTISONE ON THE FORMATION OF TENDON ADHESIONS AND ON TENDON HEALING. An Experimental Investigation in the Rabbit. By Nils Carstam. 1953. Stockholm: Acta Chirurgica Scandinavica, Supplement 182.

ATLAS OF THE SKELETAL DEVELOPMENT OF THE RAT (Long-Evans Strain). Normal and Hypophysectomized. By Hermann Becks, M.D., D.D.S., F.A.C.D., and Herbert M. Evans, M.D., Sc.D. Volumes I and II. 1953. San Francisco: The American Institute of Dental Medicine.

THE TREASURY OF HUMAN INHERITANCE. Edited by L. S. Penrose, M.A., M.D. Volume V. On *Hereditary Digital Anomalies*. Part II. On *Syndactyly and its Association with Polydactyly*. By Julia Bell, M.A., F.R.C.P. 1954. London and New York: Cambridge University Press.

CLINICAL ROENTGENOLOGY. Volume I. DEVELOPMENTAL AND SYSTEMIC CONDITIONS AND LOCAL LESIONS IN THE EXTREMITIES. By Alfred A. de Lorimier, M.D., Henry G. Moehring, M.D., and John R. Hannan, M.D. 1954. Springfield, Illinois: Charles C. Thomas, Publisher. Oxford: Blackwell Scientific Publications.

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ACKNOWLEDGMENTS

We acknowledge with thanks receipt of:

Acta Chirurgica Scandinavica, and Supplements
Acta Ortopedica-Traumatologica Iberica
Annals of the Royal College of Surgeons of England
Archives of Surgery
Boletin de la Sociedad de Cirugia del Uruguay
British Journal of Surgery
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Ortopedia e Traumatologia dell'Apparato Motore
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Surgery, Gynecology and Obstetrics
Zeitschrift für Orthopädie und ihre Grenzgebiete

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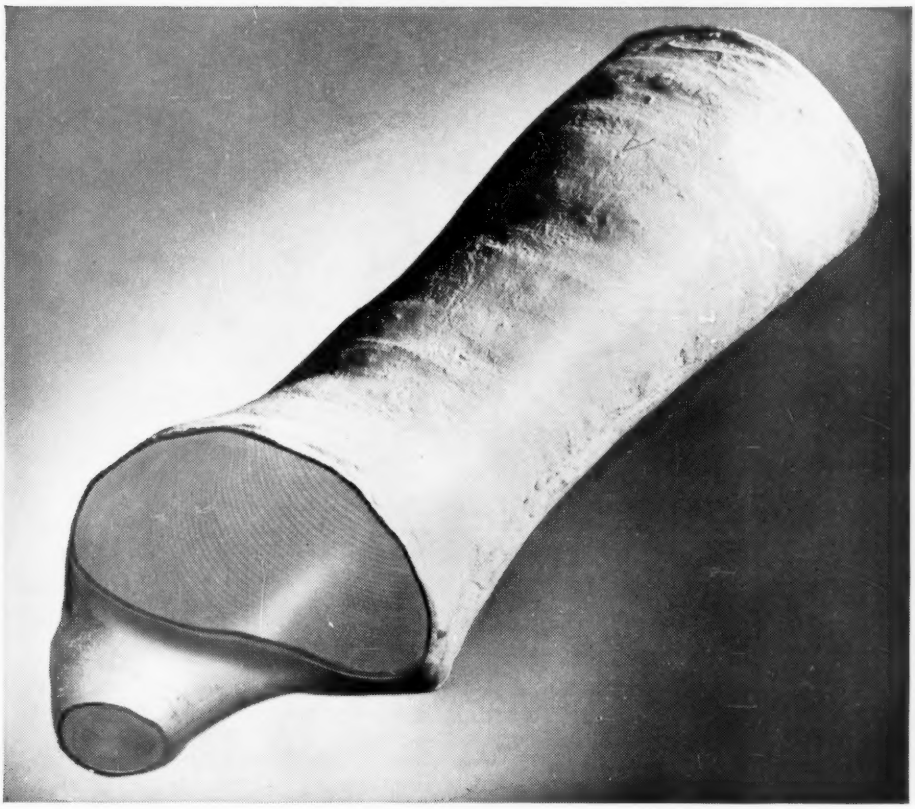

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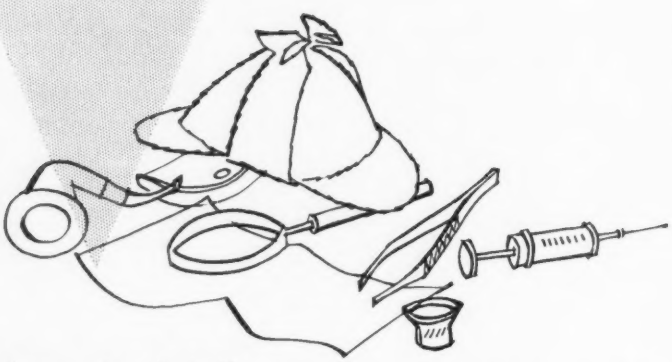

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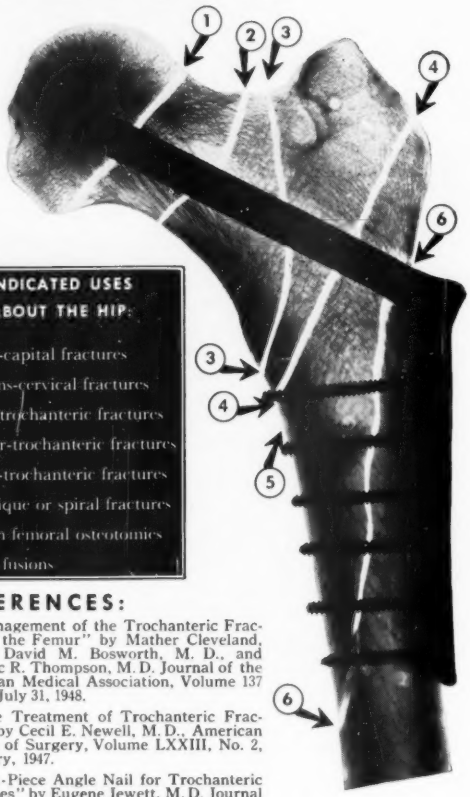

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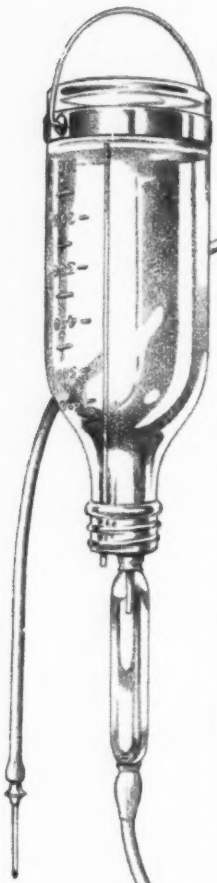

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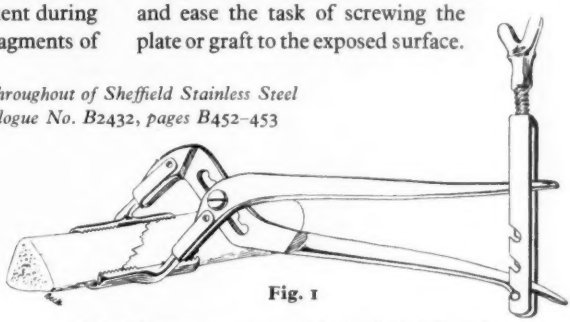

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Fig. 2
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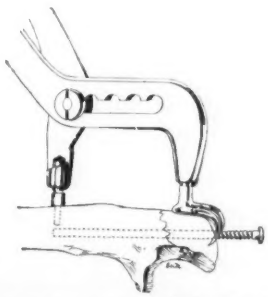

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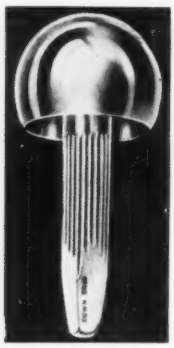

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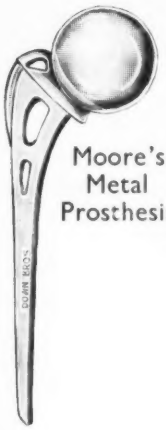

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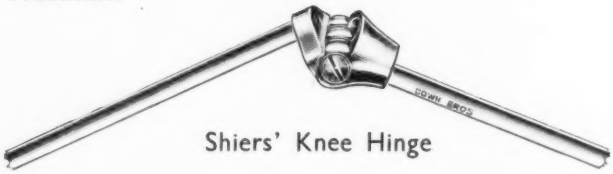

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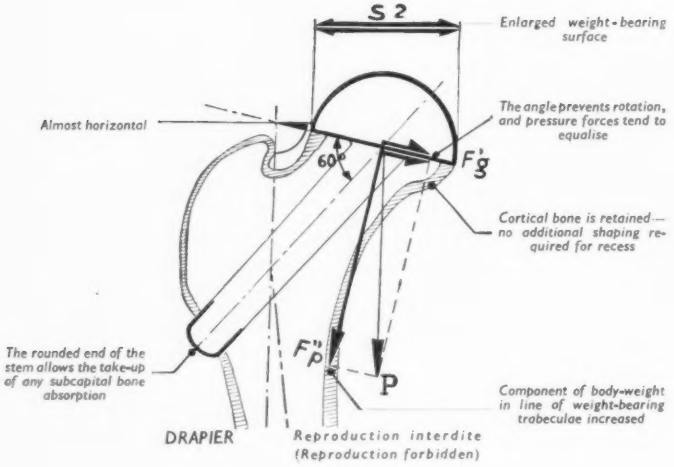
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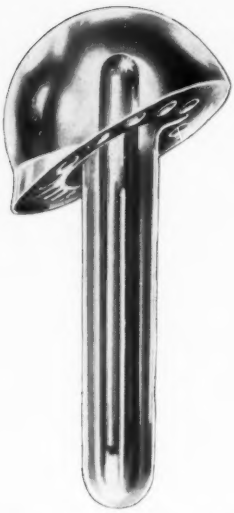

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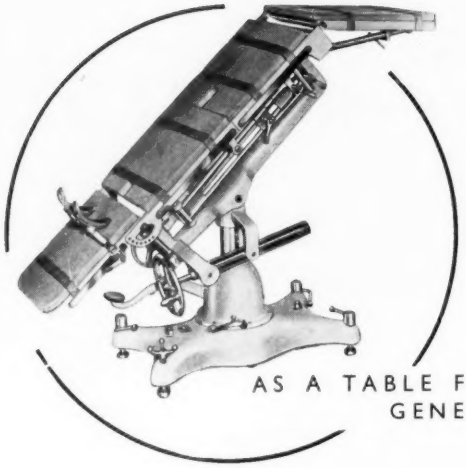

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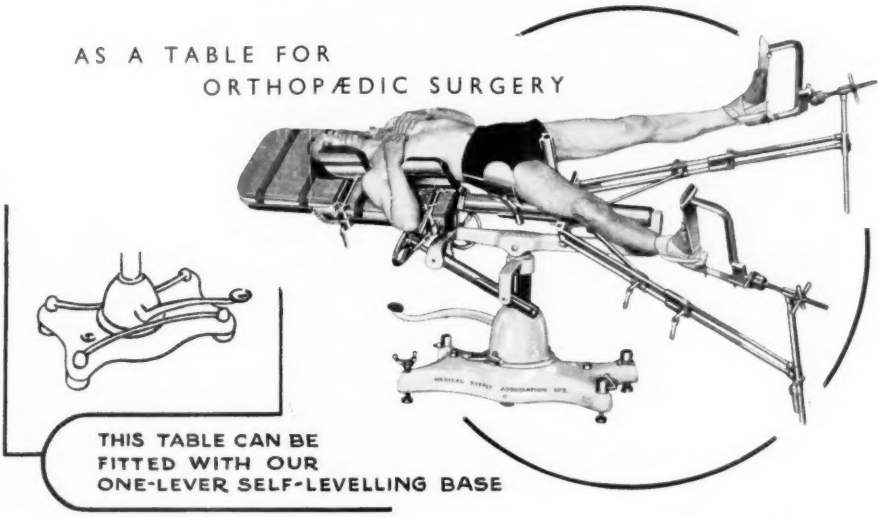

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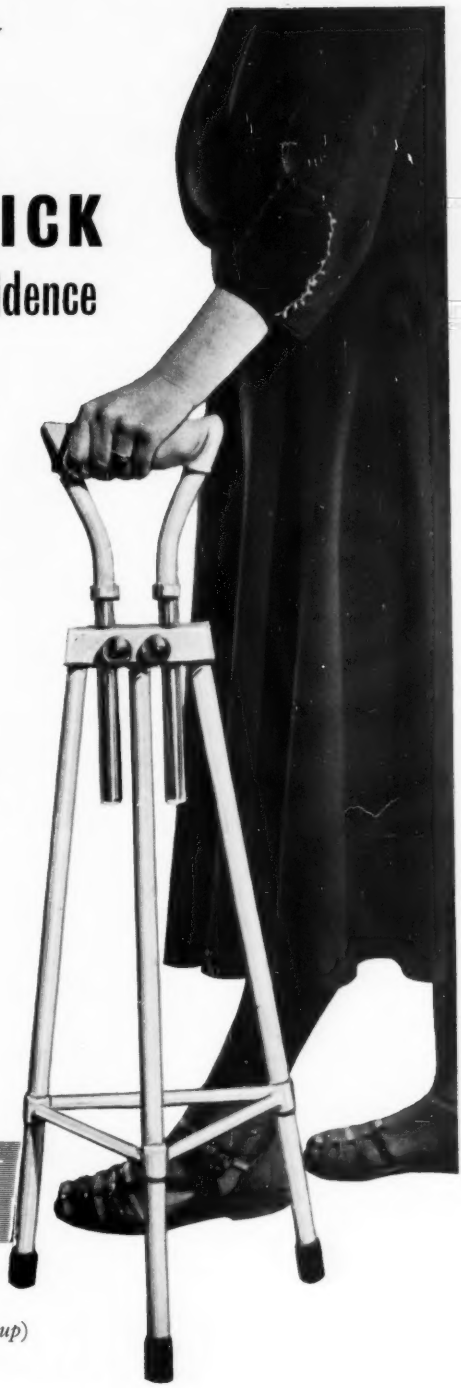

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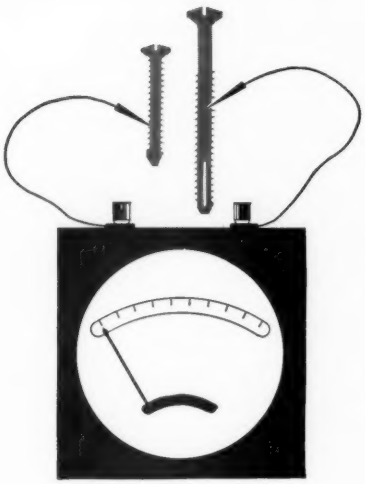

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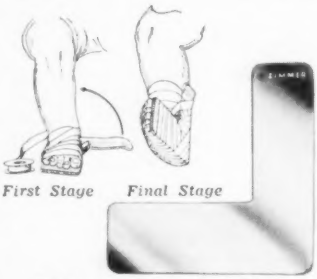

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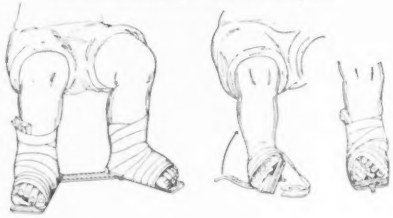

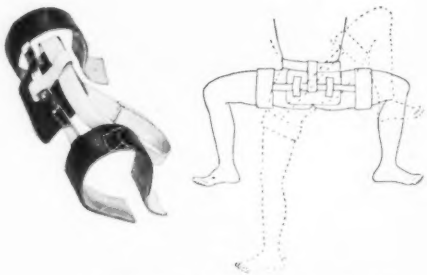

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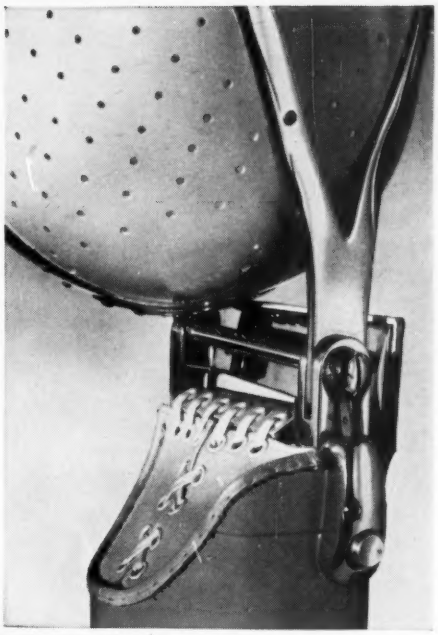

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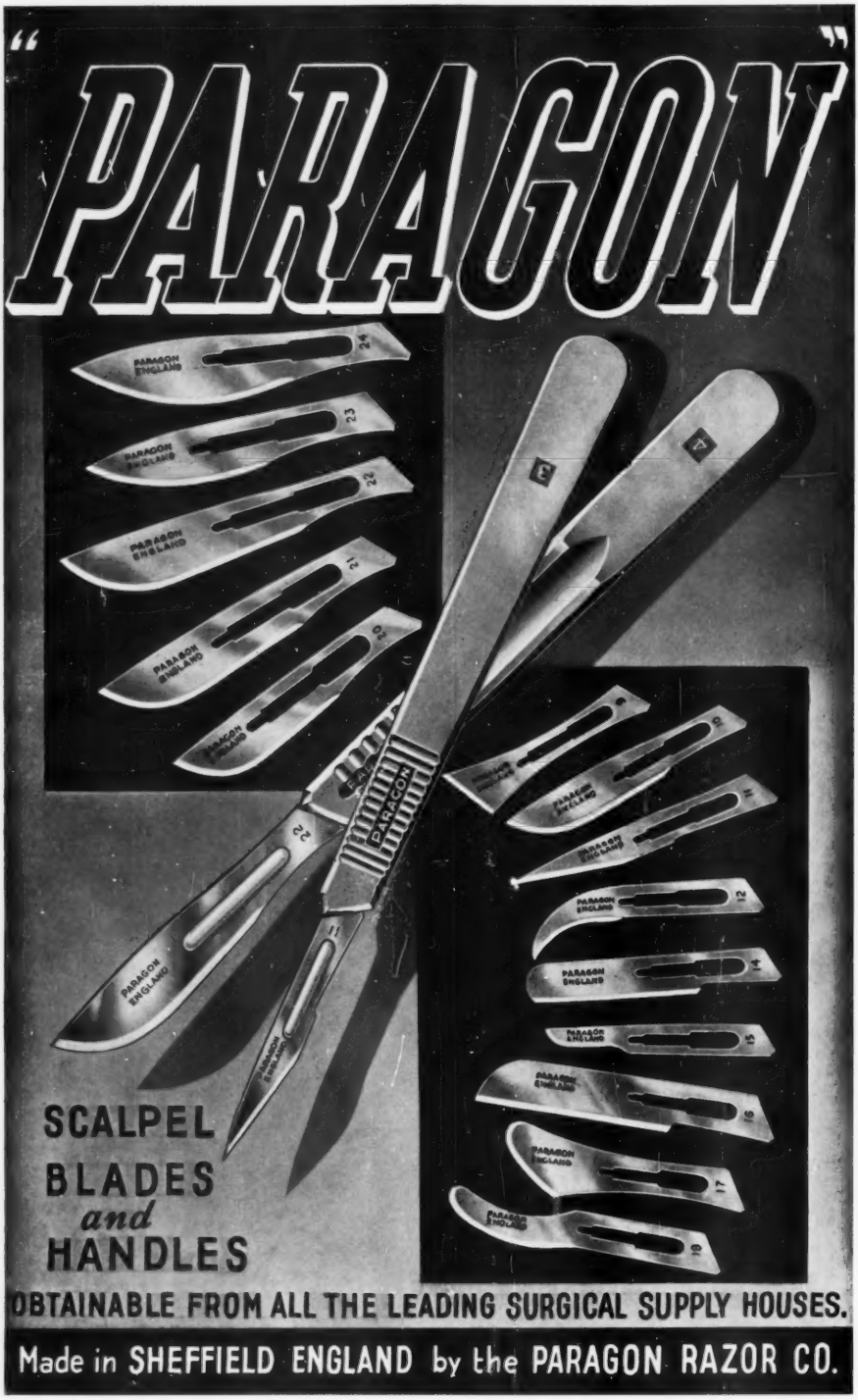

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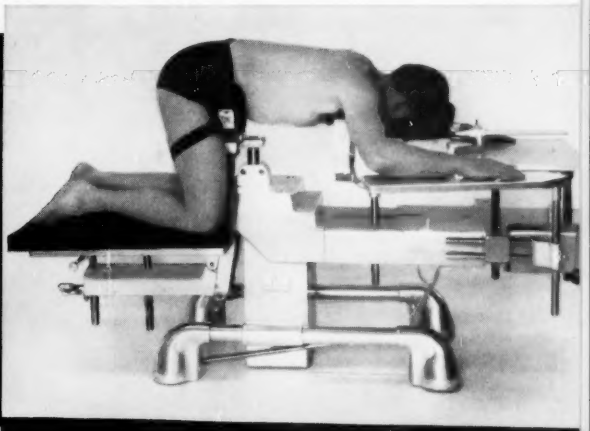

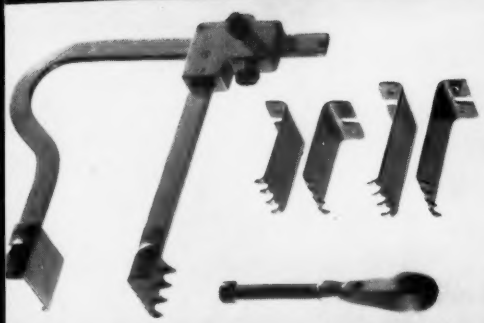

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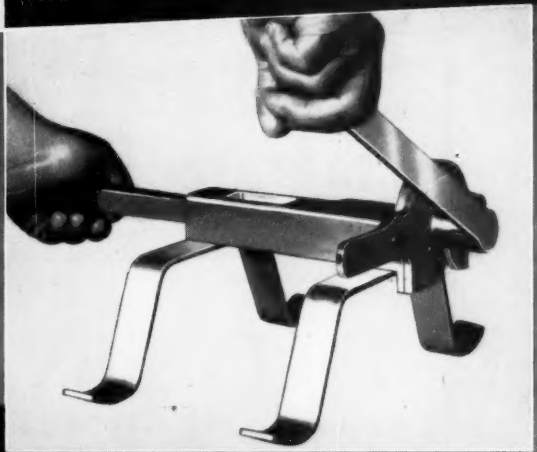

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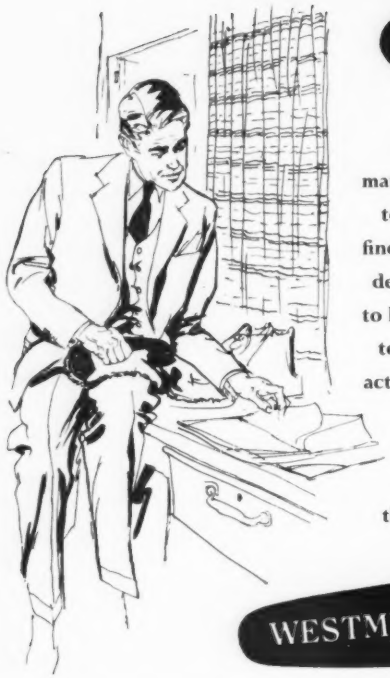

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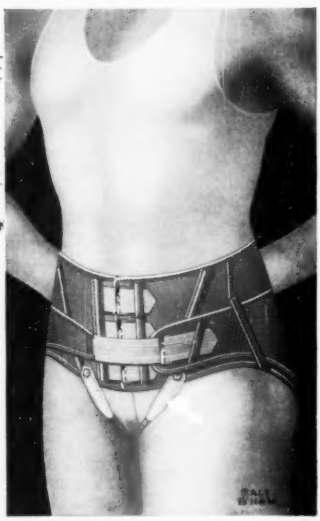

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